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SEPTEMBER, 1904. VOL. XXIV. NO. 3

The Geographical Journal

INCLUDING THE PROCEEDINGS OF THE ROYAL GEOGRAPHICAL SOCIETY.

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The
Geographical Journal.

No. 3. SEPTEMBER, 1904. Vol. XXIV.

WESTERN UGANDA.*

By Rev. A. B. FISHER.

The part of the Uganda Protectorate which I intend to deal with in this paper is that district known as the Western Province, and includes three distinct kingdoms, viz. the kingdom of Bunyoro with its king, Andareya Nziriga; the kingdom of Toro with its king, Daudi Kasagama; and the kingdom of Ankole with its king, Sulemani Kahaya. In earlier times these three kingdoms were united in or controlled by the sovereign of Bunyoro, and there is the fullest evidence of the fact that as recently as the reign of the now captive King Kabarega, the Batoro and Banyankole paid tribute to the Banyoro. The kings of Bunyoro numbered thirty-five, and it was in the reign of the ninth—King Chwa—that the Banyankole were brought under subjection. It is difficult to trace the date of the re-independence of this nation, but we find Toro remained united till the reign of Kyebambi, grandfather of Kabarega. Kyebambi gave Mwenge to one of his sons, who afterwards rebelled and ultimately succeeded in declaring Toro an independent kingdom.

In considering the ancient history of these districts under survey, we are bound to conclude that the country was well known to the earliest writers. Homer, in his map of Africa, depicts the "Mountains of the Moon;" Herodotus, in the fifth century B.C., mentions the existence of the pygmies; and Hipparchus, in 100 B.C., refers to the three inland lakes. Owing doubtless to the reverence and veneration with which the Nile was always regarded by the Egyptians, the more ardent devotees had been led to seek its source, and to thus explore these central districts. The comparative exactness with which the physical

* Read at the Royal Geographical Society, June 13, 1904. Map, p. 376.

characteristics of the Nile, the Mountains of the Moon, and the lakes were described leads one to believe that this was the result of personal research rather than mere tradition. I have not the least doubt, judging from native testimony met with on all sides, that at one time there existed a great caravan route extending along the banks of the Nile for bringing away to Egypt the African spoils of ivory and slaves. Is it unreasonable imagination to suppose that King Solomon drew his vast supplies of ivory from these directions? What other country can compete with it in its magnificent tusks, many weighing 200 lbs.? Besides this, there are many distinct traces of influences of higher civilization, even among the crudest of the tribes living close to the mighty Ruwenzori mountain range.

In the extremely delicate and diverse forms of string and basket work peculiar to the Batoro tribe, one notices marked similarity to Egyptian design. Then, again, among the tribe of the Bahuku is another suggestive point: whilst staying in their vicinity for a period of six weeks, I made a strong effort to collect together a selection of their war-horns, which consist of minute ivory tusks shaved down and scooped out. It was not an easy matter to procure them, as they are regarded as the heirlooms of the family, and have been handed down from ancient times. Offering, however, high and tempting terms in the shape of goats, I succeeded in procuring six or seven. I then found that each had its own peculiar mark: one resembled most clearly the planet Saturn, another the Pleiades, others various hieroglyphic designs. Questioning the folk as to the significant meaning of each, they expressed total ignorance beyond that they were intended for ornamentation by their early fathers. Taking into consideration the absolute ignorance and disregard of the native mind about the celestial bodies, this, to my mind, is a most unaccountable coincidence, if it does not illustrate or emphasize the point now being dealt with.

Then as regards government. If they had not modelled it after a higher example shown them, how can we account for the intricate and highly developed form of native administration which we found existing in these parts, and which the British Government was not able to improve upon for these people?

There remains still one other proof of an influence of an outside civilization, and that is in the religion of the country. As among all African tribes, the belief in general is that of devil-worship. Yet after carefully questioning the Batoro, and sifting their creed down to its foundation, it is seen that they have believed in an all-good and almighty Creator who had no beginning and can know no end; they also believe in the personality of the "king of darkness," who sends his spirits to tempt men away from good, and if allowed to be thus drawn away, they will ultimately reach his kingdom, from which there is no escape. Death, they affirm, entered the world by sin, and they have a number

of legends to illustrate the fact. The ritualism of their belief savours of semitic practice, viz. propitiation by offerings in kind, or the flesh of fowls, goats, sheep, oxen, which must all be white or without blemish; and human blood. When first visiting Bunyoro in 1895, the oldest inhabitants of the country related to me how a white man and woman many years ago landed on the right bank of Lake Albert, and settled in Bunyoro. On being questioned as to whether they referred to Sir Samuel and Lady Baker, they replied that they remembered them well, and described them to me. But, said they, these other white people arrived a long, long time ago, and founded their first dynasty. The story is that this man and his wife came down from the Nile, and

SEMLIKI RIVER, MIDWAY BETWEEN LAKE ALBERT AND ALE..RT EDWARD.

caused a great sensation, the people all flocking round them, exclaiming, "Kintu ki?" ("What is it?") So they named the man Kintu. He soon won the devotion of the Banyoro by his hunting prowess, and they made him their king. About 1892, a story, that had its origin among the tomb-keepers of a king, said to have been known as Kintu, aroused such curiosity among the intelligent Baganda that they made a search for a book, which was reported had been buried with him. Although this proved futile, the people do not discredit the story, knowing the powers of the white ants in their country to finish off anything of value. They still hold one day out of the seven as sacred, which they had been taught by Kintu.

The Batoro tell of how a white man came down from the north and settled among them and reigned over them. As a proof of their

statement, they will point to the sprinkling of very light brown colouring of the skin of many of their numbers.

The predominant and most striking physical feature of this entire district is, of course, the range of mountains known as the Mountains of the Moon. I have made very thorough investigations among the various tribes as to the possible origin of the word "Ruwenzori," and invariably found that speaking of the mountain as a whole is quite unknown to them. Each peak has its own appellation, and the nearest approaches to the word that have been given to me are "Rwensozi," which means "the mountain of mountains," and "Rwenseri," meaning "the mountain over there" (the direction referred to). It is most frequently called Birika, the only word I have heard used for "snow" among all the mountain folk. The Baganda call it "Gambalagala fumba biri," which is "the leaf that cooks the clouds." This refers to their custom of cooking all their food in banana leaves. As the mists sweep down the mountain-sides, they declare it is the smoke from the "cooking-pot."

I fully endorse Sir Harry Johnston's estimate of the approximate height of the highest peak reaching an altitude of between 20,000 to 22,000 feet. When, with Mrs. Fisher, who is the first and only lady who has reached Ruwenzori's ice, we climbed to the point which Sir Harry Johnston arrived at, I noted that my glass fell from 115° Fahr. to 28° Fahr., from an altitude of 5000 feet to 13,800 feet.

From the base to the snow-line is five days' most arduous climbing, and is attended with considerable danger. For the first 8000 feet one is pushing his way up the sides of forest-covered ridges, where ferns of every variety are found, from the male fern to the Australian tree-fern. Maidenhair shrubs, orchids, gigantic lobelias of two distinct species, are the prevailing plants. Bird and insect life from this point apparently ceased, and nothing broke the unutterable silence save the occasional rush of a glacier stream, or the thunder that crashed and roared from peak to peak. Camping space is very limited. On four days there was only room for one tent to be pitched in a very flabby manner under protruding rocks, and a slight deviation from the narrow path would have landed one some hundreds of feet below, for most of the time we were travelling along the top of a ridge which rose as an eye-tooth from river-beds. Beyond this altitude stretched bamboo forests, which terminated in thick morass and swamp, continually fed by waterfalls and streams flowing from the face of a precipitous rock. The unpleasant ordeal of plunging through this for some hours in the early morning, and the desperate climb up the almost perpendicular rock, will not soon fade from our memory. The next day's ascent was over slippery heather trunks that had fallen across tree-tops; this brought us to a swampy valley filled with 4 to 5 inches of water and soft moss. On every side water was trickling down into it from the

melting snows above. From this to the Mubuku glacier was steep climbing through loose earth covering rock, fresh-fallen snow, and over frozen puddles. We had to haul ourselves up by means of ropes over the last bare and hanging rocks, and then we were rewarded by a glorious vision of the mighty equatorial glacier which was overpowering in its magnificence.

My conviction is that those of us who have undertaken the task have made a mistake in not attacking it from its western flanks. During a more recent stay in Mboga, when I was able to compare the position with that from the eastern side, the whole panorama of snow-peaks appeared distinctly for many days. I believe no attempt has yet

PAULO TABALO, CHRISTIAN CHIEF OF MBOGA, BEYOND SEMLIKI.

been made to approach it from this side, perhaps for the reason that travellers have not made Mboga a popular field for exploration, and those few who have passed through the district may have been cheated from a view of the snows by the clouds and mists that hang so heavily on the mountain-sides as a general rule. The late Sir Henry Stanley drew attention to this hazy obstacle when seeking for a reason for the silence of his predecessors on the subject of Ruwenzori's snows.

Reaching a higher point than the Mbuku glacier from the right will always be a tremendous difficulty, and one that will involve the sacrifice of human life. Even if one's porters are chosen from the hardy mountain folk, the Bakonjo—which was the plan we adopted, and so suffered no cases of death among our caravan during those days of

intense hardship and indescribable cold—we found the natives totally unfit to endure the climatic changes for any protracted period, which must be involved if a higher point than that already reached is to be attained. My conviction is that the left-hand route would be less circuitous, and would bring one in closer touch with the highest peaks.

The whole of Toro has been subjected to tremendous volcanic action. A chain of extinct volcanoes extends from north to south, and these point to a very remote period of activity; in the craters of several are to be seen lakes, and dense vegetation growing up the sides. The people of the country have no knowledge of the true nature of these hills, tradition has suffered, like all their ancient history, from having nothing beyond verbal channels. They will tell you that these craters are the dwelling-places of the witches or evil spirits. "Kaitabaloga," which means "that which kills the witches," is the name given to them, and whenever a witch had been found, she was thrown into these craters, whence they were supposed to have come. The evil spirits are reputed to have swallowed up men and cattle; whether or no this is a contortion of the actual truth or pure legend, it is impossible to say. A tribe called Bachwezi is said to have inhabited Toro in early times, and to have suddenly and entirely disappeared, and it is a curious fact that the word used for evil spirits is "Bachwezi," and although the people do not seem to associate the *tribe* Bachwezi, as they do the evil spirits, with these craters, one is inclined to question whether there is not here a clue to the destructive forces which must once have swept away all form of life.

On account of Ruwenzori, Toro stands pre-eminently unique as regards the water system and supply when compared with other districts. An old Arab historian named El Makrisi went so far as to declare that the four rivers Gihon, Sihon, Euphrates, and the Nile had a common origin in these mountains, which were in the region of Paradise. I can only say, from my experience of six years' life in Paradise, that the Garden of Eden must have sadly deteriorated, and there is little left beyond morasses and elephant grass of gigantic growth that would be more in keeping with the mammoth epoch.

I, however, agree with him in attributing the source of the Nile to these snow mountains. From the glaciers descend innumerable streams, which grow into wild cataracts that, tumbling down over rocks and boulders, reach the plains, and, passing through the country as clear crystal streams, empty themselves into the lakes. But in addition to this supply, the mountains attract all the rain-clouds; the force of gravitation is so great that with a mighty roar the winds from all the four quarters will, as it were, rush together, and then sweep on to the mountains, where, smashing up with a tremendous concussion, they will rebound and pour down their fury on the country of Toro. This occurs more or less for nine months out of the twelve. Bunyoro, on the

other hand, offers sharp contrast; the whole district is a stretch of cone-shaped hills, occasionally relieved by a saddle-back, and contains part of that curious rift-valley called by Emin Pasha "the ribbon." This hilly condition has a deteriorating effect on the water-supply. The rains begin in March, and continue till the end of May; then follows three months' dry season. The rains accumulate at the base of these hills, and are thwarted in their effort to form a channel, owing to the barrier offered by the rapid-growing vegetation. Being thus checked, the water expands, and, with the alluvial deposits washed down, settles itself into stagnant swamps, through which the earlier traveller had to wade, the natives not considering bridges essential.

CROSSING THE MUBUKU RIVER.

The district of Bugoma in Bunyoro was until 1895 considered a dense forest extending to the Albert lake; but during a short visit to the district, I proved by entering it, that it was only a crescent-shaped belt about 2 miles deep, with its ends resting on the lake and nestling in a well-protected valley. It contains excellent timber, and rubber vines of an inferior quality.

I must not overlook that splendid river known as the Semliki, which unites the Albert Edward and Albert lakes. It lies on the western side of Ruwenzori, and is in close proximity to the great Congo forest. There is no reason why this should not be utilized as a waterway for floating down the heavy timber and the quantities of rubber from the forest, which is at present untouched. With the exception of a small cataract about the middle of its course, there is nothing to check its

cargo reaching the Albert lake, where the lake steamers could take it on. The rapidity of its flow prevents sud from accumulating. If the boundary of the British and Belgian territory is yet awaiting demarcation, I would strongly urge the importance of holding the monopoly of this central African waterway.

Observing the flat levelness of the Semliki plain, and the ridges of hills and rocks that enclose it, one would be led to suppose that the Albert lake once covered a much larger stretch of land; the cataract of the Semliki river, above referred to, might have marked its southern boundary, if it did not actually extend to and join up the Albert Edward lake. The country from Busaiga to the plain is rather remarkable. On reaching Busaiga from Toro, the land suddenly drops some 500 feet, and what appears to be a vast plain extends for a distance of some 15 miles. On descending to it, however, it is found to be a slightly undulating plateau with long intercepted parallel strata of rock, which have the appearance of railway embankments. The soil is very sandy, and sprinkled with quantities of small shells such as are found on the lake-shores. To reach the Semliki plain, one has to again abruptly descend another 400 feet.

The natural resources of the districts are partially or entirely undeveloped. Ankole might be called the ranchland of the Uganda Protectorate. There extends mile after mile of the richest pasture, and the cattle are exceptionally fine. They consist of the long-horned and hump species, and the cows give a particularly rich milk; the goats and sheep excel those of other districts, and are very numerous. The Batoro and Banyoro have neglected the cultivation of their country. They certainly are not epicureans, and are quite content to feed on a small millet called "bura" year in and year out, as it grows with very little expenditure of toil, although it contains practically no nutritive quality. The soil is particularly rich, but the excessive waterfall in Toro, and the intense strength of the sun, have the effect of forcing everything to exaggeration, and robbing all vegetation of the more delicate touches of nature in regard to general growth, colouring, and flavour. Almost anything planted will grow, and, the year having only one season, a constant crop of fruit, vegetables, and flowers can be obtained. In Toro strawberries can be had for nine months out of the twelve, and green peas, cauliflowers, potatoes, beans, marrows, etc., all the year round. This should be the colony for vegetarians, for while you can have fifteen different vegetables served up at one meal, as my cook has often treated me to, there is little temptation to have recourse to the tasteless chicken or the not-too-tender goat's meat.

On the slopes of Ruwenzori, tea could be most successfully grown; the coffee is of exceptionally fine flavour, and the marshy character of the country should make it valuable for rice-fields. In the Semliki plain, which at present is one vast stretch of waste land, I have met

with specimens of cotton which is much superior to other kinds produced in the Protectorate. The present hindrance to aggressive industries is the difficulty of transport. As the native is at present compelled to carry his goods a distance of 179 miles into Uganda if he wants to find a purchaser, there is little to encourage the people to work the land beyond providing for their own needs.

The rubber industry is absolutely untouched, and in all the forests of these provinces there is a considerable quantity. The whole country must at one time have been more thickly wooded than at present. In a district where the traveller meets with a number of large shady trees, shambas are to be found, and depend upon it, if you question the oldest inhabitant as to how the trees came there, the answer will be "Twagalonda," that is, "we selected them"—referring to the period when the district was covered with forest, and, in search of new and rich soil for their crops, they had gradually felled down superfluous trees. The fact is that isolated trees do not exist, because they have been unable to resist the annual grass fires, and even where they did manage to grow to maturity, they were then swept down by the hurricanes. The flowers have suffered in the same manner, which accounts for the marked scarcity in the country.

As regards the mineral wealth, the recent syndicate is said to have found nothing of workable value, but I cannot refrain from expressing an opinion that the river-beds, which are the tracks of the swift glacial streams, might well repay a prospector. They lie off the route taken by those who travelled through the country for this purpose.

The reason one never comes across old and well-fortified cities, as in Nigeria, is that the custom has prevailed among all the tribes of the Protectorate to change the capital with each succeeding king, and even he may change it again if the fit seizes him to move on. As all their buildings were composed of reeds and thatch, and their fences of rushes, there was no durable substance in their towns. Thus it is there remains nothing to denote the sites of their ancient capitals, beyond a few cooking-stones or slabs which had been used for grinding up their millet.

Animal life, bird life, and insect life abound in the Western Province, especially in the Semliki valley. I have seen six specimens of antelope in the Mboga district. Elephants perambulate in herds of fifty to one hundred and fifty; each herd has its advance and rear guards, which sound the alarm on the approach of an enemy. Leopards and lions are numerous; the former only trouble the inhabitants. In Toro large specimens are found; one of those I shot in that district measured 9 feet from the tail-tip to the nose. In quest of a specimen of the okapi, I was always met with the reply that they were such fierce creatures that capture was impossible. However, I have no doubt we shall soon procure a living specimen, and thus learn more definite information about its traits.

The district contains a heterogeneous collection of tribes, each with its distinguishing feature and customs. The Banyoro are the parent stock of the Baganda, Batoro, and the Bairu of Ankole. The Baganda appear to be the earliest offshoot, then the Bairu, and finally the Batoro in the reign of Kyebambi. The race has deteriorated owing to a virulent form of syphilis introduced by traders and Arabs, who have come down in large numbers from the Nile. Naturally, they possessed strong warlike instincts, but these have been crushed by the superiority of their near neighbours the Baganda. Mental freedom has been denied them by the predominant power of the devil priestcraft. In Uganda the priests always interpreted along the line of popular opinion, but in Bunyoro they had adopted the opposite plan, which had the effect of crushing independent thought and action.

The priests alone were allowed to consult with the great devil, and that through his angels, who numbered ten—Nyabuzana, Kyomya, Kagolo, Mulindwa, Ndaura, Ebona, Mugenye, Mukasa, Lubanga, and Namutali. The angels would refuse to respond unless the priest donned the crown that was peculiar to that particular deity. The demands of their belief were fourfold—human sacrifice, branding, cutting with sharp knives, and the extraction of the teeth in the lower jaw—and these were practised on every occasion of family or community trouble or sickness. A child was once brought to me with a deep wound in her forehead, caused by the mother shooting a blunt arrow at the child's head, that she might draw the blood and relieve the pain by thus expelling the evil spirit.

The Batoro have become much influenced by the physical conditions of their adopted country, as is the case with all the tribes met with in the region of the mountains. Shut in by the great mountain barrier and lying off the caravan routes, the people have become insular and their minds cramped. The terrible demands of the ritualism of their belief, namely, cupping, which was practised from infancy and continued to old age, have seriously sapped the life of the nation, and taken from the people the power and muscular energy to master their very assertive and productive soil. The consequence is that the country is very unkempt, and they own it rules them. But being convinced, does not determine them to readjust things. Then, again, the air is charged with so much electricity on account of constant thunderstorms, that this has had the effect of numbing the mental vigour and will-power of the people. If in modern warfare the bombarding of the enemy with heavy artillery is supposed to have an unnerving result on the will and crushing the spirit, so the artillery of the elements of Toro, so admirably described by Sir Harry Johnston, undoubtedly has a corresponding influence on its inhabitants.

They have, on the other hand, strong imitative instincts, which render them apt pupils. Their features are decidedly superior to the

ordinary African. The negro type of feature is a rarity, and instead one finds well-formed noses and thin lips, while the hands and feet are delicately formed except when deformed by disease, which is very prevalent in the form of syphilitic and other skin-diseases, resultant on the low moral tone of the tribe. They have discovered the properties of the boiling sulphur springs for medicinal purposes, and constructed small canals to carry off the water in order that it might sufficiently cool to enable them to use it for bathing. At a time of small-pox scare in Toro, I found that the people had a method of vaccination, which they explained was peculiar to their tribe, and known only to them. The

VIEW OF THE MUBUKU GLACIER.

Batoro, like their neighbours the Banyoro and Banyankole, practised blood-brotherhood.

The natural inhabitants of Toro were the Bakonjo, who were driven into the mountains by their invaders. They have gradually become physically suited to their new mode of life. One is struck by the muscular superiority of this race. The men are the mountain huntsmen, and they go off on long expeditions in search of the hyrax or cony. These small creatures must be almost blind and devoid of instinct. They burrow in the rocks and live together in large communities; their captors will be at the entrance to the hole, and as one after another pops out its head, it is struck down and carried off, but, apparently possessing no means of communication between themselves, no warning is given to the others, so they continue coming out in single file, until sometimes the whole family is annihilated by these Bakonjo. The people adopt no

clothing, except in some cases a few skins of the hyrax sewn together, or collobus monkey-skins are worn across the shoulder. Yet they seem quite inured to the cold that sweeps down from the snows at night. They will sleep in the open with no covering or shelter, the scanty vegetation affording no material for the erection of grass booths. Carrying wisps of lighted grass inside a sheath of bark, as night falls, they will kindle a fire and squat round in a circle with arms interlaced, and thus sleep. Unlike the Batoro, they do not build their devil temples in their courtyards, but in the forests, or wherever their most abundant spoil promises to be. I have noticed that among the people who are dependent on a particular craft for a livelihood, their religion extends to it, and not beyond. The fisherfolk round Lake Albert, for instance, will do nothing to offend the spirit, for fear of misfortune in their fishing, and practically the same idea sums up the whole belief of the Bakonjo. They live on a species of arum plant, snakes, and rats when less fortunate in their hunting. On one occasion a Mukonjo came to my house and offered to clear off the rats that had become more numerous than pleasant, and in a very short time he had replenished his larder considerably.

In Ankole two distinct tribes exist—the Bahima, or herdsmen, who are the invaders of the country, and the Bairu, the natural inhabitants and peasant class, who were given this name, meaning slave, by the Bahima. These folk are exceedingly suspicious of the Batoro, and resent any friendly overtures from them, such as have been made recently between the Batoro and the Banyoro. Their women have been kept in absolute seclusion, and are bound to cover their faces if they venture outside the boundaries of their hut, as is the custom in Mohammedan lands. This is peculiar to the Bahima, and points to the fact that the people must have migrated from northern districts. Their pronounced Nilotic features also bear this out. Doubtless they travelled down from the Nile in time of famine, and, coming across this excellent grazing-land, settled down with their cattle.

On the western side of Ruwenzori are a number of tribes varying considerably in number. One of the largest is the Balega tribe, that dwells on the western shores of Lake Albert, and extends back to Belgian territory. Their sole adornment consists of beads and wire twisted round their ankles and wrists. The chiefs will sometimes wear a cowhide. They recognize no ruling power, and have no king or leader. Each man is practically king of his own household, and, being an exceedingly prolific race and polygamy the practice, he often has a family of eighty to one hundred to control. The custom is for the whole family to live together in one house, so these reach quite big dimensions, and are constantly being added to in order to hold the ever-increasing inmates. They worship evil spirits, but the women are debarred from holding any belief, or taking a share in the religious exercises.

To the south of the Balega is the Babira tribe, who practise the same customs as the Balega. The women pierce the upper lip, and insert discs of wood varying in size from a mere thorn to a piece resembling a five-shilling coin, according to the rank of the woman.

The Bahuku, who live in the forests that stretch along the Semliki plain, are a strong and sturdy tribe. They allow their hair to grow to the shoulder, and twist it into streaks or tassels by means of goat's fat. The marriage custom is for the women to be given in exchange

MR. AND MRS. FISHER ON THE MUBUKU GLACIER.

for another, or goats, when this is not possible. They still indulge in cannibalism among themselves. The smallest offence is the call to arms, and the scene of bloodshed is quickly cleared of its fallen warriors. They seldom honour their dead with burial, which the upper class will always allow to their goats and sheep, but the corpses are sold for one or more goats to another family.

The Bambuba live on the fringe of the great Congo forest. They vary in height from 4 to 5 feet. Their cultivation is exceedingly crude the trees are felled, and Indian corn, beans, and sweet potatoes are sown

round the roots. They will not eat human flesh, except that killed in warfare. Polygamy exists among them, but each wife has her own house and servants. They build their devil temples among the long grass; only the old women are allowed to visit them with their offerings besides the men, who blow a horn to acquaint their wives with the time of their offering. They bury their dead in a sitting posture, with the hands folded across the chest; for six days the head is left unburied, so that the friends might gather round and mourn over the dead. After that period the burial is completed, and the grave kept well swept until arrangements are made for the household to move elsewhere.

The Batwa or pigmy tribe are their neighbours, and are the parasites of the tribes living round. From all the information I could gather during my visit of six weeks in Mboga district of the forests and from personal intercourse with them, I should say they are not a numerous tribe; they have suffered terribly from famine and small-pox in recent years. They do not cultivate, but live on hunting spoils and plunder. An elephant is the biggest bag and the tusks are exchanged with the Baamba for bananas, who use them for trading, or with the Bahuku, who convert the small ones into war-horns. The difficulty of procuring a good specimen of the okapi is no doubt owing to the creature's well-nigh extinction at the hands of these spirited little hunters. The constant call for self-defence against their stronger and sometimes plundered neighbours has made them a fearful and vindictive little folk. The semi-obscurity of the forest doubtless has resulted in their stunted growth. Their bodies are covered with an almost imperceptible down, which grows on the arms in the same direction as on the monkeys —that is, it meets towards the elbows. As they always sit with arms clasped round the neck, the constant rains falling off the trees might account for this. As regards mental calibre, I should say they are much in advance of the tribes living outside the forest. It may be, that, being continually on their guard against the wild animals that infest the forest, their minds have become more alert and active. Certain it is that they show a quickness for learning, and I have noticed that, while seeking to instruct a mixed class representing five different tribes, the pigmy will grasp an idea more readily and correctly than his competitors. If we are to look to him physically for Darwin's missing link, we cannot do so psychologically.

In conclusion, I would say that what forced itself on me while living among these people of the western province is that deterioration is naturally stamped everywhere, or, if we must admit evolution, it must be the evolution of evil. Whether we speak of the general features of the country, or the spiritual, mental, and physical characteristics of the people in their natural condition, demoralization is the outstanding feature. But there are tremendous political, commercial, scientific, and psychical possibilities if we, as Britishers of the

Protectorate, are willing to direct our interests in not only this western province, but Uganda as a whole.

The Uganda railway has cost the British Government £7,000,000 to construct. What return have we got to justify this great outlay? We have, in the words of Lord Rosebery, "pegged out a claim for futurity." We are effectually able to control the headwaters of the Nile, which is the life of Egypt. The slave trade has received its death-blow, and the warships which looked after the slavers on the East Coast can now be used elsewhere. The cruelties of human porterage have disappeared, and inter-tribal wars have ceased. The missionaries have been able to carry on their good work in peace; thousands of the natives have become Christians, and under the present enlightened policy of our able and kindly High Commissioner, Colonel Hayes Sadler, C.B., education is encouraged and industries fostered. In short, the Uganda Protectorate is like a spring day, everything bursting into life.

The implicit trust and confidence which the inhabitants have in Colonel Hayes Sadler and his able Deputy-Commissioner, Mr. George Wilson, C.B., have increased their loyalty to our nation, and have inclined them to settle down to the development of their country, so that we may look, in the near future, for a very large increase in the export of coffee and cotton from the Protectorate.

The Uganda Protectorate is, in my opinion, the greatest asset of our nation in all East Africa. The inhabitants are to a great extent Christian, exceedingly intelligent, progressive, and most loyal—facts which will always secure the peace, not only of the Protectorate, but also of the surrounding territory.

Before the reading of the paper, the PRESIDENT said: I have pleasure in introducing to the meeting one of those pioneer missionaries, Mr. Fisher, who for the last fifty years have done so much for the exploration of Africa. He will give you an account of his experience in Western Uganda, which I feel quite sure will be extremely interesting and valuable. I now call upon Mr. Fisher to address you.

After the reading of the paper—

Mr. J. F. CUNNINGHAM: I fear I have very little to say, except to give expression to what all of us feel—our gratification at the interesting address that we have heard. Most of you, perhaps, think that it is quite easy to write original matter regarding Uganda and the territories adjoining. But I think you would alter that opinion if you tried it. No Society knows better than you how many able men have visited that district, and how thoroughly they have described it. I might mention General Lugard, Sir Harry Johnston, Mr. Moore, Major Powell-Cotton, and Mr. Grogan—all of them very careful observers and admirable descriptive writers. Where these men have travelled and described, it is not an easy matter to pick up new information, and yet Mr. Fisher has managed to get a great amount of original information together. I think I know why. Mr. Fisher is known locally as a very expert linguist; he knows several native

languages, and he has lived in close personal relations with the tribes he has described. It is to that, I think, we owe the essence of the interesting discourse to which we have listened. There are certain subjects—botany, for instance—that the ordinary traveller may describe. Botany has no secrets; its history is written on the leaves and stems of every plant. The same may be said of geology to a certain extent, because geology has an outcrop to guide the observer and the traveller; but to describe the intimate personal habits of these tribes cannot be done without an intimate knowledge of the language of these people. That Mr. Fisher has. What strikes me as most remarkable is that he should have described all these people without a trace of exaggeration in any one particular that I can allude to. I have collected some information myself regarding these people, and may at once say that I owe it, not to myself personally, but to the information I have been able to glean from the missionaries. When a missionary settles down in any one particular district, his first aim and object is to master the language of that district. Having mastered it, his station becomes a centre of religious instruction; not only that, but it becomes a centre of secular instruction also, and, as you have seen from the photographs shown on the screen, not only are these mission stations centres of secular and religious instruction, but a considerable amount of work is done in the matter of handicraft. You have seen how the natives have been taught to make bricks, and how they have been taught to build houses of a serviceable kind. All that is the work of the missionaries. Now, Mr. Fisher has covered almost the whole of this map that I have in my hand, and I am afraid of keeping you too long, but in regard to the Bahima people—and just to start a discussion for any one who wishes to follow—in regard to the origin of these tribes and the other tribes along there in Ankole and Toro, I might mention that I have found an additional matter on which to base, in a slight way, a belief in the fact that these people are of a northern origin. Mr. Fisher has alluded to a certain method of hairdressing amongst the Bankole, and other matters. Now, in addition to that, the women of Ankole are a very closely veiled people; they never expose their features, and they are always confined to their private apartments. As you know, that is not a Central African custom; it has a tendency to lead one to Egypt to account for that, and I believe the white man—the Kintu that Mr. Fisher referred to—would be considered white if he were an Egyptian coming amongst these people, who are perfectly black. On the other hand, I have made a great many measurements of the heads of the Ankole people, and I find that they are dolichocephalic, and this leads one to the conclusion that in that one respect they resemble the Somalis and the Egyptians. Now, the Ankole people have a religious belief in a future state. Mr. Fisher has not touched on that; but the King of Ankole himself and his ministers told me that the future state for the elect is called Mitoma. It is not placed in Ankole, but it is far away beyond German territory, and the entrance to that place is a sort of mystic tunnel in the Ankole forest. The king himself gave me an imitation of the noises made by the spirits in passing into that tunnel. I am sorry I cannot attempt an imitation. Well, this state is a state of perfect rest—there are no clothes required there; there is no herding of cattle, no work, no cultivation of bananas, no food required, no drink, and, mind you, it is not intended for the righteous alone. The wicked go there as well as the good. Every one is admitted there except the peasantry. The Bairu, or working class, are not admitted to the Mitoma of the Ankole people. Not only are the Ankole people interesting in this way, but they have given to the Bakonjo people a god. This god, I found out from the people themselves, was originally an Ankole man. He was driven out of Ankole, and he was accepted by the Bakonjo. A

man, you know, is never a prophet in his own country. His great qualification for being a deity was not a small one in this twentieth century—he was bullet-proof; he was also spear-proof, and these two qualifications alone were quite sufficient to recommend him to a naked people who were not bullet-proof. I have asked one of the officials of the Geographical Society to prepare a lantern slide showing three of these people worshipping at what they call the temple of their ancestors.

Now look at this picture of the hukiko sitting in session. That is the Uganda parliament. You see, as in your parliament, they are ranged in two columns, but they are not in opposition. That is the king in the chair, in the dark over there, and these are the leading chiefs. If it would not be too wearisome, I will tell you how the house is composed. There are eighty-nine members. I was almost tempted to call it the mother of parliaments, because, I believe, it was in existence before our own, but its present constitution was given to it by Sir Harry Johnston. Uganda is divided into twenty provinces; each province has a separate member who draws £200 a year. There are three Regents and twenty county members. Each county also selects three of its notables. We have not got to any ballot-box election at the present time, but public opinion points out who are the distinguished men of the county, and these people take their seats in this parliament. In addition to them, there are important persons who may be connected with the royal house of Uganda, or who have distinguished themselves either in the past or in fighting for or against the mutineers, or in some other way, and these are entitled to a seat in this House—making eighty-nine members. Now, there is no dissolution in this house, because, I suppose, there are no parties. Probably that will come later on. But, at all events, a member of this house, if he becomes obnoxious to the king, cannot be removed on account of expressing his opinions freely. The Commissioner on behalf of the Government has a veto in removing any man, so that prevents any unjust treatment so far as a free expression of opinion is concerned.

Rev. Canon SMITH: I will only speak just a few moments, and the interest of what I have to say lies in the direction of pointing out what extraordinary progress has been made during the last fourteen years. Fourteen years ago I was journeying to Uganda through German territory, and at that time the country scarcely belonged to us at all. It is since those days that we have acquired, without dispute, the territory of Uganda, and I can recollect the time when General Macdonald came into Uganda for the purpose of surveying for the railway. I can also remember when there was only one church in the whole of the Uganda Protectorate. I can also remember when the first octagonal house was being built, and at that time it was necessary to hold sticks and threats over those who carried on the work. When I mention this, you will understand what extraordinary progress has been made during the last fourteen years. Some intensely interesting questions have been raised by the remarks of Mr. Fisher to-night, and I had hoped there might have been time to speak about them. I will only refer to one of these questions to which I allude, namely, the distribution of the black man over the whole of Africa. From which point did that distribution commence? is a question suggested to my mind to-night. My own belief is that it began from the north-eastern part of Africa, and the black people have been gradually driven across to the West Coast. I make this remark partly because it is my duty now to work on the West Coast, and it is only a week since I landed from Sierra Leone, and during my work there I have been intensely interested in noticing questions and subjects of similarity and dissimilarity from those things I observed on the East Coast. And just speaking for a moment, I would suggest one or two special subjects which this Society through its members might make a study of. I believe

we have paid far too little attention to the mourning and burial customs of these people. Then, again, I think we have shown far too little notice to the signs of primitive art which may be discovered throughout the whole of Africa. Some are extremely primitive, but they are all suggestive; and I think if we pursue the question, we shall yet learn a great deal about the past history of these people. I would only say one more thing, and that is, there was a photograph shown which referred to the extraordinary character of the waves on Victoria Nyanza. Twice I have crossed the lake, and, curiously enough, I was one of those who occupied a boat during that particular storm the picture of which was shown to you to-night. That picture was taken by Bishop Tucker, and I was with him when it was taken. Now, I have travelled over the ocean both on the east and west coasts of Africa, and I can assure you I have never seen any condition of the ocean waves which seemed to correspond in magnitude with the waves on the Victoria Nyanza. I think that is a subject of interest, and it leads us to inquire how these gigantic forces are brought into existence, and what they all mean, in the course of our future studies.

The PRESIDENT: I think we must now thank Mr. Fisher for his most interesting paper. The pioneer missionaries of Africa, from the days of my old friend Dr. Livingstone until now, have done a very large share—more, I think, than their proper share—a very large share indeed of the exploration of this great continent. We have recognized their work on more than one occasion by giving our Gold Medals to pioneer missionaries and our other Awards, but I do not think any of those missionaries have excelled Mr. Fisher in the careful studies he has made of the tribes with which he has come in contact. I am sure none have given us a more interesting evening. I propose, therefore, to you that you should pass a very cordial vote of thanks to Mr. Fisher for his paper, and also, as Mr. Cunningham has suggested to us, that we should combine with that vote the name of Mrs. Fisher. I think we are also bound to thank Mr. Cunningham and Canon Smith for their most interesting addresses.

Had time permitted, Captain C. RODNEY MUNDY would have made the following remarks: There are one or two points in the interesting lecture we have heard to-night to which I should like to briefly refer. In the first place, with regard to the origin of the Ba-Hima, many things seem to point to their having come from the north-east, and of a Semitic rather than a Hamitic stock; and I think there can be very little doubt that they were originally a light-skinned race, although there are now plenty of dark Ba-Hima to be found—this, I think, being due to a mixture of negro blood. They are, of course, a purely pastoral race of cattle-breeders, and the true Mhima will not touch anything but beef, milk, cold water, thoroughly despising the banana and all its products. Neither will he touch mutton, even when almost starving, nor grain. Now, it is an interesting fact that there is in Central Africa another race of originally light-skinned, thin-lipped, Semitic people, who are in their original state pure cattle-breeders, and are nomadic equally with the Ba-Hima. I refer to the Fulani or Fulbe, who, although they are now the ruling race in a large part of the hinterland of West Africa, were originally merely nomadic herdsmen. When I was in Northern Nigeria, and conducting a few inquiries into the habits, etc., of the still nomad portion of the Fulani, I was very much interested to discover several words and expressions, especially connected with their cattle, which are identically the same in Fulani and Lu-Hima. The origin of the Fulani is also lost in obscurity. Is it not possible that both these races are descended from some common stock, and have migrated in divergent directions from somewhere to the north or north-west of Darfur? Secondly, with regard to what Mr. Fisher has told us with regard to lakes

Albert Edward and Edward having formerly been much nearer together than at present—there is plenty of evidence to show that Lake Albert Edward was once much larger than it is at present. I was particularly struck with the unmistakable proofs I found that the southern shore has long been receding northward, and is still doing so at the present day, at a fairly rapid rate. On the other hand, there is some reason for thinking that before the Mfumbiro chain of volcanoes was thrown up the drainage of Lake Albert Edward was south to Lake Tanganyika, and not north to Lake Albert; and these volcanoes cannot be of very ancient date.

GEOGRAPHICAL DISTRIBUTION OF VEGETATION OF THE BASINS OF THE RIVERS EDEN, TEES, WEAR, AND TYNE.*

By FRANCIS J. LEWIS, F.L.S., Assistant Lecturer in Botany, University of Liverpool.

PART II.

The area now under consideration lies immediately to the north of Part I., the eastern and western boundaries of the two maps being continuous. The field work for this paper was begun at the same time as Part I., and was finished last autumn. The boundaries of the various plant associations have been laid down upon the 6-inch Ordnance maps in the field, and subsequently reduced on to the 1-inch maps for publication. The maps now published are contoured every 100 feet up to 1000 feet, then every 250 feet up to 2000 feet, and above this height the contours are given every 500 feet. The lower limit of the Alpine moorland follows the 2000-feet contour-line very closely, but elsewhere the plant boundaries have no direct connection with the contour-lines, frequently running at right angles to them. The boundaries have been fixed by the landmarks shown upon the large-scale maps, such as piles of stones, sheepfolds, scars, and streams] The height of most of these landmarks are given on the 6-inch maps, and can easily be identified with the aid of a good aneroid registering to 50 feet, the aneroid being frequently checked during the day by means of the summits.

Topography.

The area now under consideration covers the rising ground of the Tees, South Tyne, and Wear, and includes Sheet 25 and part of Sheet 24 of the 1-inch Geological Survey. The water-partings consist of two main ridges, the Cross Fell chain on the west forming the water-parting of the Tees and Tyne and part of the drainage system of the Eden, and the Weardale Fells on the east. The former ridge trends north-west and south-east, and rises abruptly from the Eden valley to a height of 2930 feet on Cross Fell, and does not fall below 2500 feet

* Continued from vol. xxiii. p. 331. Map, p. 376.

for a distance of 5 miles in a south-easterly direction. From Cross Fell the level of the ground falls rapidly to the east into the Tees basin, and to the north into the Tyne basin. A range of hills runs north-east from Cross Fell, and forms the parting between the Tees and South Tyne.

The Weardale Fells consist of a central ridge running almost north and south, which bends round to the east at each end, and is continued on each side of Weardale to the eastern limit of the map—on the south at a general level of 2000 feet, and on the north at about 1700 feet. A considerable area of country thus lies above 2000 feet, the actual figures being 41 square miles.

Nearly the whole of the present area consists of unenclosed moorland, except the narrow cultivated dales of the Wear and South Tyne, Harwood, and a small strip of the Eden valley in the south-west of the map.

Rock exposures, such as crags and scars, although not frequent, are found chiefly at lower levels, although scars frequently occur at 2000 feet on the western escarpment, sometimes being continued for considerable distances, as in the case of Melmerby High Scar. Above 2000 feet the ground consists of bleak, gently sloping moorland, often arranged in a series of flat terraces.

In Weardale the tributary burns from the watershed flow down short, wide, upland dales or "hopes," which differ greatly from the narrow, steeper, and longer ravines or gills of the Cross Fell chain. The former are generally grass clad, the latter usually covered with heather.

Geology.

The district consists entirely of Triassic, Permian, Silurian, and Carboniferous rocks. The Triassic and Permian are confined to the Eden valley on the south-west of the map. Much of this area is covered with a thick deposit of earthy gravel and till, and is under cultivation. The rock exposures chiefly occur in the neighbourhood of Melmerby and Ousby, and by the sides of streams, and these areas are generally well wooded, oak occurring in considerable quantity, mixed with other trees.

From Melmerby south-eastwards, the Permian and Triassic region is bounded by an area of Silurian rocks, which form a series of rounded hills and pikes standing between the Eden valley and the western escarpment of the Pennines. Most of these hills are pasture clad, with a considerable mixture of *Vaccinium Myrtillus*.

The whole of the area to the east of the main Pennine fault is formed of Carboniferous rocks, the lower series consisting of limestones and sandstones, and an upper series consisting mainly of sandstones, grits, and shales, traversed by a few thin beds of limestone.

These districts show clearly the difference, both in configuration and vegetation, of hill masses formed of the two types of rocks which have

been named by Thurmann (1849) dysgeogenous and eugeogenous. The hills formed of the former kind of rock yield only a small amount of detritus, whilst a much larger amount is yielded by the latter. The thick shales and grits of the Weardale watershed, traversed by only a few thin beds of limestone, are typically eugeogenous, upon which flourishes a wet type of heather vegetation. The hills of the Cross Fell chain, on the other hand, are much more dysgeogenous in character, for, although traversed by beds of grits and shales, the limestone beds are much more massive, and occupy a greater area than on the Weardale Fells. These hills support a vegetation of a drier type than the purely eugeogenous hill. The differences in the vegetation covering these two types of hills will be considered more in detail when the vegetation of the moorlands is under review. The Whin Sill is well exposed along the western escarpment, forming a prominent feature in nearly all the gills which furrow the face of the western slopes. It is also exposed at several stations on the eastern side of the Pennines, the largest exposures being situated by the side of the Tees from Dead Crook to High Force.

Most of the upper moorland regions bear a thick covering of peat, which in many places rests upon glacial clay, and which has been seen to occur as high as 2450 feet on the eastern slopes of the main Pennine ridge.

A full description of the glacial phenomenon of this region is given by Mr. J. G. Goodchild in the *Quart. Jour. Geol. Soc.* (1875), and by Mr. Dwerryhouse in the same journal for 1902.

The geology of that part of the area lying within the counties of Northumberland and Durham is described in 'The New Flora of Northumberland and Durham,' by Mr. J. G. Baker (1881), and this work also contains summaries of the salient features of the flora in different areas in Northumberland and Durham.

Area of Cultivation.

The area of cultivation only covers 63 square miles, and the greater portion of this is under permanent pasture. The whole of the Eden valley, and the bottom of the dales of the Tyne, Wear, and Allen included in the boundaries of the map, are under cultivation, with occasional patches far up the hillsides. The only region in which cereals are grown at the present time lies in the Eden valley and in Weardale east of St. John's Chapel.

No wheat is grown within the limits of the present map, the chief crop being oats. The upper limit of this region of cultivation rises at the foot of the western escarpment of the Pennines to a height of 800 to 900 feet in some places, though its general level is about 600 feet. Above this a fringe of permanent pasture is met with, stretching to the limits of cultivation. In most of the dales cultivation extends to a much

greater height than in Part I. In Tynedale the general level of the upper boundary of cultivation lies at about 1750 feet on the east side, and 1000 feet on the west, with two outlying patches (Calvertfold and Shellwell) near Tynehead at 1850 feet. The same general level is reached in Nentdale. In Harwood cultivated land is met with as high as 1950 feet at the hill farms of Grass Hill House and Manor Gill House, and only slightly less elevations at which cultivation is carried on are met with in Weardale. The pasture at these altitudes, however, is often wet in character, and with the same general flora as the surrounding grass heaths.

Although all the records of rainfall lie within the region of cultivation, they are of interest as showing the great increase of rainfall in the neighbourhood of the main Pennine ridge.

Zone of vegetation.		No. of observations.	Altitude above sea-level.	M.A. rainfall.
			Feet.	Inches.
Oats	Penrith	12	575	31·78
Near limit of oats cultivation	Melmerby	6	583	36·63
Permanent pasture ...	Alston	5	1145	49·03
" " ...	Allenheads	4	1353	42·39
" " ...	Wearhead	3	1104	48·70
Near limit of oats cultivation	Eastgate	4	798	37·75
Wheat	Bishop Auckland	10	408	25·54

Woodland.

The natural woods are entirely deciduous, and occur as straggling copses by the sides of streams, in gills chiefly on the borders of the Eden valley in the western region of the map. Amongst the mixed deciduous woods, hazel and ash are less frequent, and rowan and birch generally more plentiful, than in Part I.

The chief trees occurring in the stream-side copses are—

Corylus Avellana, L.
Betula verrucosa, Ehrh.
Pyrus Aucuparia, Ehrh.
Alnus glutinosa, Medic
Fraxinus excelsior, L.
Quercus Robur, L.

None of the other deciduous woods rise higher than 900 feet on the western side of the main Pennine ridge, and 1500 feet on the eastern side, and these altitudes are only attained in the most sheltered places. Isolated shrubby trees—chiefly willow, birch, rowan, and ash—occur occasionally as high as 1700 feet by the sides of scars in deep ravines, but there are very few places where even stunted trees are found so high.

Pine Woods.

Several fairly large plantations of Scots pine occur in the Eden valley, in Tynedale, and in Weardale, the highest elevation attained being 1600 feet at Greencastle, and about 1750 feet at Allenheads. At

FIG. 1. Birches in Ashgill.

FIG. 2. Spruce plantation on Ashgill Head at 1,750 feet.

these altitudes the trees are straight and well grown, but above this they tend to become dwarfed and stunted, and although occurring frequently in the large spruce plantation at Ashgill up to 1700 feet, they thin out rapidly after this height is reached.

Examination of the peat has been made to collect evidence whether the Scots pine is indigenous in this area. Some stations have been discovered on Cross Fell at 2400 feet, and one of these is shown in Fig. 4, but I was quite unable to find the extensive pine remains referred to by Nathaniel Winch (1825). He says—

"On the elevated moors between Blanchland, at the head of the Derwent, and Wolsingham, on the river Wear, and even on the mountains of Cross Fell, at an elevation of nearly 3000 feet, the roots and trunks of very large pines (*Pinus Sylvestris*) are seen protruding from the black peat moss, being exposed to view by the water of these bogs having drained off and left the peat bare; but this tree is no longer indigenous with us."

Undoubtedly the peat upon the higher moors is being denuded very rapidly, but it seems scarcely possible that nearly the whole of these extensive remains should have been denuded away since the time this was written, but careful search during the field-work for this map has only revealed the remains I have mentioned, and the wood here is of quite small size; but it is probable that the more extended and numerous sections through the peat which I am making in sub-alpine districts will yield further remains. Most of the plants characteristic of primitive pine woods occur in this district—though in most cases very sparingly—such as *Linnæa borealis*, *Pyrola minor*, *P. media*, *P. rotundifolia*, *P. secunda*, *Trientalis europæa*, *Listera cordata*. Their rarity, or even their absence from modern pine plantations in the district, proves nothing in the face of pine-wood remains in the peat, particularly when we remember that the primitive pine had probably disappeared ages before any artificial planting took place.

Spruce Woods.

The greater number of coniferous plantations consist of spruce, much of it having been planted in the days when mining operations were carried on in the district. A small amount of planting is being done for the supply of the few mines still working; but in most cases the coniferous plantations east of the main ridge of the Pennines are in a state of decay.

The largest wood occurring in the present area is at Ashgill, and this rises from the side of the North Tyne at 1200 feet, and runs up the hillside to 2015 feet. The lower portion of the wood consists chiefly of deciduous trees, ash being the most prominent. This portion of the wood is now very thin, no replanting having been carried on for many years, and each winter takes its heavy toll of blown-down trees. To

the east of the Alston-to-Middleton road, which runs through this wood, nearly all the trees are spruce. A slight mixture of rowan, ash, beech, and pine occur up to 1700 feet, but after this level has been passed we meet with only spruce, Douglas fir, and a few larches. Beech occurs as a fringe outside the western margin of the wood at 1600 feet, and appears to withstand the severe winds remarkably well; but there is no evidence that it has ever been indigenous in the district.

The chief interest centres in the narrow strip of plantation which runs up from the main body of the wood at 1750 feet to 2015 feet. This consists entirely of coniferous trees — spruce, Douglas fir, and larch—all rather small, and many assuming almost a creeping habit. The larches in particular, at about 1900 feet, show well-marked elfin growth, the stem being almost prostrate, not more than 3 or 4 feet in length, with long, strongly curved drooping branches. Many of the spruce stems lie closely pressed to the ground, having been blown into a horizontal position by wind, though some of the roots have still retained their hold upon the soil. The whole of this part of the plantation would probably have been swept away before but for the protection afforded by a 6-foot dry stone wall, which encloses the plantation from the surrounding fell land. Some instructive evidence of wind-action is also to be seen at the summit. Here the spruce forms a dense shrubby growth about 2 or 3 feet in height, almost like the spruce mats mentioned by Kihlmann (1890) as occurring near the northern tree-limit in Russian Lapland. These mats are dotted over the surface of the ground at varying distances from the shelter wall, and they appear to be due to the natural spread of the planted spruce. This plantation affords the only example of woodland above about 1700 feet, and the rapid stunting in the growth which takes place at above 1800 feet, and the shrubby habit assumed by all trees at 2000 feet which are not directly sheltered by artificial means, afford some confirmation of the adoption of the 2000-feet contour-line as the lower limit of the Alpine region. It may be pointed out that the Ordnance station at 2015 feet is by no means an exposed summit ridge, but the edge of an almost level plateau which extends for about 1½ mile to the south-east, rising there to the summit of Burnhope Seat at 2452 feet. In the case just described, Douglas fir appears to withstand the desiccation produced by the wind at a high altitude better than any of the other conifers, spruce coming next. No example of Scots pine was observed above 1750 feet.

Birch Woods.—No regular birch woods are found in the present area, small birch copses only being present in a few cases by the sides of streams. The same extensive birch wood remains that were met with in the Part I. area have been noticed here and traced to higher altitudes. No widespread remains have been found on the western escarpment of the Cross Fell chain, but on the north-east slopes, *i.e.* in the basins of the Tees, Tyne, and Wear, the traces of former birch

FIG. 3. Shrubby growth of spruce at 2,015 feet on Windy Brow.

FIG. 4. Pine remains exposed by the denudation of the peat, S.E. of Cross Fell at 2,500 feet.

woods meet the eye everywhere. These remains can be traced over all the Vaccinium and Heather moors, and Eriophorum and Heather moors (VH and EH on the map) in Upper Teesdale, are continued over Tynehead Fell, though not so abundant here; whilst the Eriophorum, Vaccinium, and Heather moors (EVH) and the Eriophorum and Heather moors of the Weardale Fells appear to have supported dense birch woods at some post-glacial period, the eastern slopes appearing to have been more thickly covered than the west. Briefly stated, nearly all the Heather areas, both in Parts I. and II., appear to have supported woodland, the wood in most cases having been birch. This ancient forest appears to have run up nearly to the summits of the highest fells, plentiful remains having been found at 2600 feet on Cross Fell, 2500 feet on Knock Fell, and 2350 feet on the Weardale Fells.

The present birch thickets are confined to sheltered places, such as small ravines and hollows, always near the heather moorland, and they appear to be the representatives of the ancient birch forest. Passing south from the present district, remains of birch, alder, and oak, have been observed by Messrs. Clough and Barrow (Memoirs Geological Survey, 1891), in the peat covering the upper part of Wensley Dale, Swaledale, and Arkendale, extending up to 2050 feet, and in fact such tree-remains—chiefly birch at the higher levels—have been observed all along the Pennines from Derbyshire to the Cheviots. Such buried forests appear to be almost a constant feature of the peat in Great Britain and Northern Europe generally, and the same feature has been observed in the peat beds of some parts of North America. The widespread occurrence of tree-remains so far above the general level of woodland at the present day seems strongly suggestive of a change of climate, and this is borne out by an examination of the peat at different depths.

Microscopic examinations of the peat show that *Sphagnum* was predominant at intervals during the deposition of the peat beds, certain layers being wholly formed of the leaves, stems, and capsules containing the spores of this moss. Again, these beds of *Sphagnum* merge into peat containing numerous remains of shrubby plants, such as *Empetrum*, *Calluna*, *Vaccinium*, which again in some cases give place to birch remains. The existence of these buried *Sphagnum* beds are noteworthy in connection with the present scarcity of *Sphagnum* in the area. The sections which have already been made during the progress of this survey also show a considerable change in the character of the plant-remains towards the base of the peat. Near the glacial clay birch is either absent or rare, and its place is taken by shrubby Alpine willows, some six species of which have already been recognized, together with the remains of Alpine plants which are either uncommon or altogether absent from the district at the present day—a vegetation strongly suggestive of tundra conditions.

Graebner (1901) has found that extensive heather areas in North Germany have been formed from forest, and in view of the extensive remains of woodland on all the heather moors along the Pennines and at all altitudes, the same origin of the heather moors may be claimed here.

Much of the heather moorland of Parts I. and II. below 1500 feet appear to be well adapted for reafforestation with mixed coniferous wood, more particularly the heather moors on thin peat to the east of the Pennine ridge. When the peat becomes deeper and wetter, however, a moor-pan is nearly always present, and planting on an extensive scale would probably entail considerable difficulties. Most of the hopes in Weardale, the gills in Teesdale below High Force, and in North Tynedale would with scientific management support extensive and profitable mixed coniferous woods. It is interesting to note, in connection with the woodland, that only 3¾ per cent. of the total area of Parts I. and II. are now covered with woodland. The actual figures are—

Total area of Parts I. and II.	...	...	...	560 square miles.
Area covered with woodland at the present time ...		...	11	„

The area in which traces of former forest have been noted during the field work is about 140 square miles. This is excluding the area of cultivation, most of which we may assume was under primitive forest.

Sub-Alpine Moorland. Natural Pasture.

The best development of pasture is to be seen in the neighbourhood of the limestone scars which form a conspicuous feature of the south-west slopes of Cross Fell below 2000 feet, being well developed on thin calcareous soil often not more than a few inches in depth. Two small areas of pasture occur near Belbeaver Rigg, on small outcrops of limestone only a hundred yards from an extensive Eriophorum bog, and it is interesting to note the changes in vegetation between these two areas. The pasture area is surrounded by a border of well-developed Nardus grass heath only a few feet in width; outside this is a broader zone of grass heath with Eriophorum, the external edge of which rapidly shades into Eriophorum bog. The transition is well shown in the autumn even at a distance, the bright green of the pasture contrasting with the white Nardus zone, the brownish Eriophorum grass heath, and the surrounding sombre dark-hued Eriophorum bog. The pasture is developed on a thin limestone soil, the border of Nardus heath on glacial clay free from peat, the Eriophorum grass heath on thin peat, which rapidly deepens when the Eriophorum bog is reached. The flora of the pasture does not differ materially from the scar pasture of Part I.

The boundaries between the Pasture and grass heaths have not been defined on the maps, and they are both represented by the same colour with a view to avoid complication, but the position of the more

FIG. 5. Boundary of Calluna Moor, and Grass Heath with Eriophorum on Redbourne Edge.

FIG. 6. Looking North across Tynedale from Cross Gill. Grass Heath slopes in background, Birch Wood in the gill.

important pasture outcrops have been indicated by lettering. The area so covered is much less than in Part I., the present district being a typical dry grass heath and wet heather country.

Grass Heath.—Grass moor attains a much greater development over the present area than on Sheet I., and extends as a broad fringe covering all the lower slopes of the Weardale Fells. A steady increase in its area can be noted as we pass eastwards from the highest region of the Pennine watershed. Two chief types can again be recognized—(*a*) Grass heath developed on steep dry slopes nearly free from peat; (*b*) Grass heath developed on deep wet peat-covered ground and in hollows.

(*a*) *Grass Heaths, developed on Steep Dry Ground.*—The dominant plant in such situations is invariably *Nardus stricta*, and many of the steep hill slopes are covered with an association composed almost entirely of this plant, mixed with a few plants characteristic of dry peat with a sprinkling of pasture plants. The following list of plants from the eastern slopes of North Tynedale at Windy Brow are characteristic of most of the drier grass heaths:—

* *Nardus stricta*, L.
Juncus squarrosus, L.
Potentilla tormentilla, Scop.
Galium saxatile, L.
Vaccinium Myrtillus, L.
Lotus corniculatus, L.
Trifolium repens, L.
T. medium, L.
Festuca ovina, L.
Deschampsia flexuosa, Trin.

Two chief intermediate types of this Nardus grass heath are formed. In one case the Nardus may occur with a considerable quantity of *Vaccinium Myrtillus*, in the other type Nardus occurs in company with Calluna. These two intermediate associations have been distinguished on the map as grass heath with Vaccinium (VGH) and grass heath with Calluna (HGH). Much of the western escarpment of the Pennines above the Eden valley is covered with the Nardus and Vaccinium type of grass heath, particularly below the Vaccinium Edge, which extends from Stoney Rigg to High Scald Fell on Sheet I. Where this type of grass moor is well developed, there is often a tendency for *Deschampsia flexuosa* to replace Nardus as the dominant plant, and this can be well seen near Cuns Fell on the Cross Fell chain, where the Nardus has been replaced to a great extent by *Deschampsia flexuosa*, *Juncus Squarrosus*, and abundant *Vaccinium Myrtillus*. As the quantity of Vaccinium increases, Nardus becomes replaced more and more by *Deschampsia flexuosa*.

The association of Nardus with Calluna (HGH) is well represented on the slopes of the fells to the east of Harwood, in Tynedale, and in some parts of Allendale. On all the lower slopes, particularly when heavily stocked with sheep, there is a general tendency for Nardus

* The nomenclature of the London Catalogue, 9th edition, is followed throughout.

to replace Calluna as the dominant plant. The author has reliable evidence, from many different sources, that many of the areas which are now covered with a Nardus-Calluna association were, half a century ago, covered with Calluna moors. On most of the drier Calluna moors Nardus is always found, forming little patches of grass heath in the drier places. In some of the areas mentioned, the constant treading, manuring, and browsing by the sheep, to which the Calluna has been exposed, has had the effect of killing it, and its place has been taken by Nardus and other grasses typical of dry conditions.

(*b*) *Grass Heath developed on Wet Peat-covered Ground.*—Much of the ground on the higher slopes forms a series of gently sloping terraces, and on these a distinctly wetter type of grass heath is developed, dominated by such grasses as *Molinia varia*, with a slight mixture of *Eriophorum vaginatum*.

This association is richer in species than the Nardus heath, the following being the principal plants:—

Molinia varia, Schrank.
Agrostis vulgaris, With.
A. canina, L.
C. flava, L.
C. pallescens, L.
C. fulva, Good.
C. panicea, L.
Carex ovalis, Good.
C. curta, Good.
Scirpus cæspitosus, L.
Juncus conglomeratus, L.
Juncus lampocarpus, Ehrh.
Hydrocotyle vulgaris, L.
Sphagnum, spp.

When the ground becomes flatter, and particularly at higher altitudes near the Heather-Eriophorum area, this association becomes mixed with a greatly increased quantity of Eriophorum, distinguished on the map as grass heath with Eriophorum (EGH).

Deschampsia cæspitosa is frequently a prominent grass in this association, and in many cases it replaces Molinia as the dominant plant.

A list of plants from a grass heath with Eriophorum area on Tynehead Fell is as follows:—

Molinia varia, Schrank. } Dominant.
Deschampsia cæspitosa, L. } Dominant.
Eriophorum vaginatum, L. } Dominant.
Scirpus pauciflorus, Lightf. } Dominant.
Sphagnum, spp.
Juncus conglomeratus, L.
J. lampocarpus, Ehrh.
Carex flava, L.

The two best-represented varieties of grass heath in the present area is Nardus and grass heath with Eriophorum. The former is best developed along the lower and drier slopes of the fells in Tynedale and Weardale, and can be seen at its best on Windy Brow near Tynehead and at Redbourne Edge in Rookhope. The determining factors in the distribution of these two types of grass heath appear to be water and peat. Numerous sections have shown that the Nardus heath is always developed on thin peat or glacial clay situated on a steep well-drained slope, whilst, on the other hand, Eriophorum grass heath occurs on thicker (sometimes 1 or 2 feet) peat, with an iron-pan either in course

FIG. 7. Calluna slopes in Cross Gill.

FIG. 8. Calluna Moor on Bolts Law, Rookhope.
Scattered Nardus in middle foreground.

of formation or already formed. Some of the valleys show striking contrasts in the vegetation covering the opposite slopes. In Upper Tynedale above Alston the eastern slopes are covered with dry grass heath, the dead stems of Nardus tinging them almost to whiteness in the latter months of the year, and contrasting strongly with the dark heather-covered fells of the Cross Fell chain on the west. A decided increase in grass heath takes place as we pass further eastwards. Weardale and many of the hopes leading from it are typical grass-heath valleys, and Nardus is generally prominent, although the upper part of the fells is covered with a wet association of *Eriophorum*, *Calluna*, *Rubus Chamæmorus*, and *Vaccinium Myrtillus*, sometimes degenerating into Eriophorum bog.

The upward limit of the grass heath and the lower limit of the heather formation coincide closely in many cases with the boundary of the limestone and shale beds. Limestone crags are in little evidence in the Weardale district, and, where developed at all, generally occur low down in the dale. Above 1500 to 1800 feet the limestone is largely replaced by thick beds of shale and flaggy sandstone, and it is on these latter that grass heath is replaced by heather associations. Looking eastward from St. John's Chapel, Weardale appears to be entirely grass-clad, and it is only on ascending above 1800 feet, and in some cases 2000 feet, that the whole of the watersheds are seen to be covered with wide-stretching moors dominated by the wettest types of heather associations. The same features are to be met with in upper East and West Allendale and in Harwood.

Heather Association.

The heather associations resolve themselves into three chief types, distinguished primarily by the relative abundance of Eriophorum and secondary plants.

(*a*) Heather moors developed on dry slopes and in most cases on shallow peat.

The plants forming this association are almost identical with those forming the Heather moors of Part I. A list of the typical plants is as follows :—

Calluna Erica, DC. Dominant.
Juncus Squarrosus, L.
Nardus stricta, L.
Deschampsia flexuosa, Trin.
Vaccinium Myrtillus, L.
V. Vitis Idæa, L.
Scirpus pauciflorus, Lightf.
S. cæspitosus, L.
Empetrum nigrum, L.
Galium saxatile, L.
Rumex Acetosella, L.

The area covered by this association shows a striking shrinkage from that of Part I. It forms in the present area an irregular fringe round the wetter types of Heather association.

(*b*) The Heather association occupying the largest area consists

almost exclusively of *Calluna Erica* and *Eriophorum vaginatum*. Reference to the accompanying map will show that this association covers the whole of the sub-alpine region of Teesdale and all the sub-alpine heatherlands of Weardale. It is developed on the deepest peat, often underlaid with a well-formed moor-pan. The Calluna is somewhat stunted, generally not growing so high as the Eriophorum, which seems to flourish exceedingly well. No dry peat plants are to be met with in these areas, the only change in the vegetation being occasional colonies of such plants as *Vaccinium Myrtillus*, *Scirpus pauciflorus*, *Sphagnum* spp., *Rubus Chamæmorus*, *Empetrum nigrum*. Lichens are fairly abundant, the most plentiful being *Cladonia rangiferina*.

This association generally passes downwards into grass heath with Eriophorum or into Nardus grass heath, but with well-drained peat it passes into Calluna moor. Above the 2000-feet contour-line it changes into the Vaccinium and Calluna with Eriophorum (EVH) moor.

Eriophorum Bogs.

Where the peat becomes very wet, with but few natural drainage channels, the Calluna almost entirely disappears, and the dominant plant is Eriophorum. Sphagnum may be present under these conditions, but is not generally a prominent feature in the vegetation, being confined chiefly to boggy pools and scattered patches amongst the clumps of Eriophorum. Denudation is usually rapid in such an area, and bare peat is common.

Some of the areas mapped as Eriophorum bogs appear to differ considerably from one another both in origin and present appearance, although both are dominated by cotton grass. In some places *Eriophorum vaginatum* is the dominant species, mixed with a very small quantity of Calluna, much stunted and only 2 or 3 inches in height. Some of such Eriophorum bogs appear to have been covered with a much greater quantity of Calluna at some former period, as the bleached stems may be seen partly buried among the now luxuriant Eriophorum. Most of the Eriophorum bog mapped at Black Band is of this character. It strongly suggests a burnt area of heather and Eriophorum moor (EH), the Calluna being replaced by the more rapidly growing Eriophorum. In other cases *Eriophorum angustifolium* is the dominant species, mixed with a smaller quantity of *E. vaginatum* and a few individuals of wet-peat plants, such as *Rubus Chamæmorus*, *Erica Tetralix*, and *Empetrum nigrum*.

The succession of the different types of sub-Alpine moorland are extremely well shown along some of the "edges" in Weardale and the neighbouring "hopes." At Redbourne Edge, in Rookhope, the summit moorland at 1850 feet is covered with Eriophorum bog, which farther towards the edge merges into heather and Eriophorum moor. The summit is almost flat, gently sloping to the east, and draining into

FIG. 9. Succession of moorland vegetation on Redbourne Edge. Eriophorum Bog on the summit plateau. Nardus Grass Heath developed on the slopes below, changing to Grass Heath with Eriophorum as the wet, gently sloping foreground is reached.

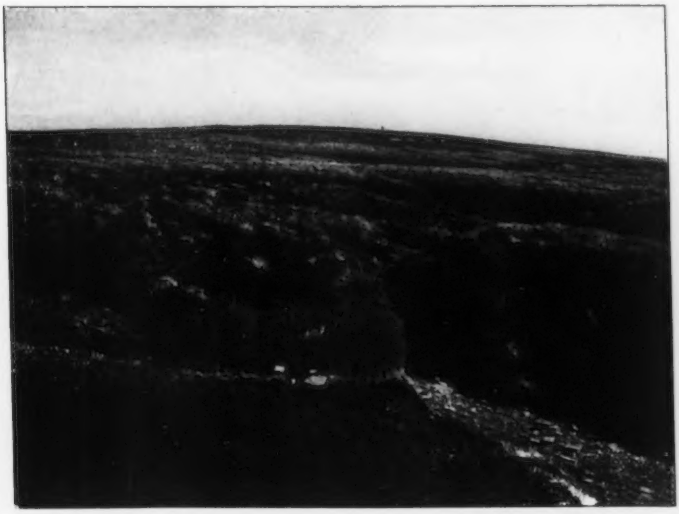

FIG. 10. Calluna and Vaccinium vegetation at summit of Deadstones. Eriophorum, Vaccinium and Calluna association in foreground.

East and West Allendale, and the underlying shale and sandstones are covered with deep wet peat, with numerous scattered pools of water between the clumps of Eriophorum. The only drainage is by channels which have been cut in the peat by rills. As the edge of the bog is approached the peat becomes drier, Eriophorum disappears, and the vegetation consists of a narrow band of Calluna moor. From here the ground slopes away sharply, and peat is absent, and upon this slope a typical Nardus grass heath is developed. As the slope merges into the gently inclined moor below, the soil becomes wetter, and peat again makes its appearance. As these conditions obtain, Nardus disappears, and its place is taken by a type of wet grass heath dominated by *Molinia*, *Deschampsia cæspitosa*, mixed with an almost equal quantity of *Eriophorum vaginatum*. This sequence of associations may be repeated several times before the bottom of the hope is reached.

Thus we have nearly all the chief types of grass heaths and Heather associations well shown within a few hundred yards of each other—Eriophorum bog upon the flat summit moorland yielding to Eriophorum and heather moors, and finally heather moor as the better-drained edge is reached, the dry peat-free slope being occupied by Nardus, which yields to the wetter type of Eriophorum grass heath as the flat terrace is reached. This alternation of moorland associations, where so sharply marked off as it is at Redbourne Edge, can be seen at a long distance, particularly in the latter months of the year, when the white Nardus heath stands out in vivid contrast to the russet-coloured Eriophorum bogs above and Eriophorum grass heath below.

Alpine Moorland.

The moorland of the Cross Fell chain is dominated by Calluna and Vaccinium, being the continuation northwards of the Alpine moorland mapped on Dufton Fell in Part I., and the lists which are given there of the dominant plants of the Vaccinium and Heather moors apply also to the Cross Fell moors on the present map. The only change that has been noted is a slight increase in the relative amount of Eriophorum present.

A much drier type occurs on rocky slopes with shallow peat, in which *Calluna* tends to disappear, *Rubus Chamæmorus* and *Eriophorum* are altogether absent, and the vegetation is made up of *Vaccinium Myrtillus*, *V. Vitis Idæa*, with *Juncus Squarrosus*, and a small quantity of *Nardus*. A nearly continuous strip composed of such an association extends along the south-west edge of the Cross Fell range from Melmerby Fell past Stoney Rigg to Brown Hill. South of this the vegetation changes to grass moor across the south-west slopes of Cross Fell, until High Scald Fell is reached, when *Vaccinium* again supersedes all other vegetation, and is continued with little interruption to Backstone Edge on Sheet I. This *Vaccinium* band lies very near and slightly above

the 2000-feet contour-line for a distance of about 9 miles, and follows very closely the outcrop of the Whin Sill. Well-marked outliers of *Vaccinium* occur on the steep eastern face of Dufton Pike, Brownber Hill, and Roman Fell at 1950 feet on Sheet I.

Passing to the Weardale Fells, a change can be noted in the character of the Alpine moorland. *Calluna* is still abundant, but it is mixed with an increasing quantity of *Eriophorum* and *Rubus Chamæmorus*. This is particularly noticeable on the long stretch of moorland from Currick End to Three Pikes, forming the water-parting between the Tees, Wear, and Tyne. The whole of the ground here is formed of shales and flaggy sandstones, and is typically eugeogenous in character. The following list of plants represent almost the only vegetation occurring on this area:—

Calluna Erica, DC. Dominant.
Eriophorum vaginatum, L. Dominant.
E. angustifolium, Roth. Abundant in places.
Vaccinium Myrtillus, L. Generally distributed, but not abundant.
Rubus Chamæmorus, L. Everywhere abundant.
V. Vitis idæa, L. In drier spots, chiefly on the summit ridges.
Empetrum nigrum, L. Abundant.
Sphagnum, spp.

This list is typical of most of the Alpine moorland of the Weardale Fells, but considerable local changes occur. In some places on Burnhope Seat, Deadstones and Knoutberry Hill, *Rubus Chamæmorus* may cover the ground to the exclusion of all other vegetation.

Two well-marked varieties of the above association, which has been designated EVH on the map, can be recognized as occurring under different conditions of moisture.

(1) Under conditions of extreme moisture the *Eriophorum* becomes dominant, and *Calluna* and *Vaccinium* almost or entirely disappear, thus producing an Eriophorum bog almost identical with those found on the sub-Alpine moorlands, the chief difference being the greater abundance of *Rubus Chamæmorus* on the Alpine area. Many of these areas are small in extent, and merge almost imperceptibly into the surrounding EVH moor. The best example is to be seen at Yad Moss, on Burnhope Seat, almost the only plants to be found here being *Eriophorum angustifolium*, *E. vaginatum*, *Rubus Chamæmorus*. A number of surface drains have been cut here, and the drier conditions thus produced are rapidly restricting the amount of *Eriophorum* and tending to produce an EVH association. (2) On many of the dry, wind-swept summit ridges *Eriophorum* disappears, and *Rubus Chamæmorus* becomes much less frequent, the vegetation being composed of stunted *Calluna*, *Vaccinium Myrtillus*, and *V. Vitis Idæa*.

Over the whole of the Alpine moorland, and the greater part of the sub-Alpine moors above 1500 feet, there is striking evidence of the denudation to which the peat is being subjected at the present time. From the Baron Hills on Cross Fell, looking south-east, the eye takes in

FIG. 11. Vegetation of Alpine moors. Eriophorum, Vaccinium and Calluna association with Rubus Chamæmorus, on Burnhope Seat at 2,300 feet.

FIG. 12. Denudation of the Peat at Yad Moss at 2,300 feet.

nothing but the long stretch of moorland on each side of the Tees as far as the foot of the Weardale Fells, scarred and furrowed by deep channels cut in the peat, in some cases to a depth of 17 or 20 feet. In many places large areas of black peat are quite unoccupied by any vegetation and strewn over with the remains of ancient birch woods, which are continually being exposed as the peat wastes away. Although over much of this area the peat is of the average thickness of 20 feet, yet in some places the denudation has been so rapid that large areas of the underlying glacial clay are laid bare. The moorlands now under discussion have been altered less by artificial agency than any other part of the Pennines. They are far removed from any large towns, not used as water-catchment areas, untraversed by any roads, and unaltered by any attempts of reclamation. Heather-burning is carried on to a very limited extent, and not at all above 1800 feet. A few surface drains have been cut on some of the lower moors towards Hartside, and these appear to be rapidly restricting the amount of Eriophorum, but the only interference with the natural drainage to the south-east of Cross Fell for the first 8 miles of the course of the Tees is a few channels cut in the old mining days to feed three artificial tarns near Cashwell Mine and a few near Tynehead. So far from these accelerating the denudation of the peat, they would tend rather to retard it by carrying off the surplus water from springs in well-defined channels.

Sphagnum is generally distributed over the moorlands, but in most cases it forms quite a subordinate feature in the vegetation, and, as far as the writer could judge, very little peat seems to be forming at the present time.

At about 2200 feet on the east side of Cross Fell the heather association gives place to grass heath, which, however, is still mixed with a good deal of Eriophorum, with occasional patches of Calluna and Vaccinium up to 2500 feet, where the ground rises abruptly in a series of steep terraces, and the vegetation merges into drier grass heath. As the ground becomes more level near the summit plateau, occasional peat dunes make their appearance, the intervening ground being still covered with grass heath. These dunes are often more than 4 feet high, and are the only remains of a thick bed of peat which once covered the whole of the ground, and they afford good evidence that the climatic conditions have changed since the peat beds were in course of formation.

The summit plateau, at about 2900 feet, is occupied by a scanty vegetation, growing between the bare patches of peat and rock, composed of a few stunted members of the heather and grass heath associations, and boggy pools containing Eriophorum and Sphagnum. The higher and drier part of the plateau is covered with living and decaying *Racomitrium lanuginosum*, forming mounds of peat, weathered away to a vertical surface on the south-west side.

During the course of the survey many sections through the peat have been made on the Cross Fell range and on some of the Weardale Fells. The sections have sometimes been carried down to a depth of 17 feet to the base of the surface peat bed, and continued through 4 or 5 feet of glacial clay below, and a succession of plant beds varying in thickness from 2 to 8 inches has been exposed, separated by layers of stiff grey glacial clay.

The plant remains from these different inter-glacial beds is very dissimilar, and show that considerable climatic changes have taken place. The author is now extending these observations, and comparison will be made with the remains of peat beds outside the present area, both in Scotland and in Ireland, and the results will be given in future papers.

Alpine Grass Heaths.

As the upper limit of the Calluna and Vaccinium moors is reached at about 2150 feet, the vegetation changes into Eriophorum and stunted Calluna, with much *Vaccinium Myrtillus*. As the ground becomes steeper and drier, this gives place to grass heath, whilst on the steepest slopes pasture is encountered. The vegetation over much of the Alpine grass heath consists of the following plants:—

Juncus squarrosus, L.
Deschampsia flexuosa, Trin.
Poa annua, L.
Nardus stricta, L.
Agrostis canina, L.
Molinia varia, Schrank.
Calluna Erica, DC.
Vaccinium Myrtillus, L.
Eriophorum vaginatum, L.

The Nardus of the sub-Alpine region is here largely replaced by *Juncus squarrosus*.

Alpine pasture is well developed on some parts of Cross Fell and Milburn Forest, chiefly on the dry limestone and sandstone bands. The most abundant grass on the former is *Sesleria cærulea*, which in some places forms the only vegetation, as on Stoop Band. Alpine plants are confined to spring heads, the sides of rills, and grassy places, and occur chiefly on the Cross Fell chain. The following occur in the present area:—

Thalictrum alpinum, L.
Draba incana, L.
Thlaspi alpestre, L.
Cochlearia alpina, H. C. Wats.
Dryas octopetala, L.
Saxifraga stellaris, L.
S. Hirculus, L.
S. hypnoides, L.
Sedum villosum, L.
Epilobium alsinefolium, Vill.
Galium boreale, L.
Arctostaphylos Uva-ursi, Spreng.
Vaccinium uliginosum, L.
Andromeda Polifolia, L.
Gentiana verna, L.
Bartsia alpina, L.
Polygonum viviparum, L.
Tofieldia palustris, Hud.
Carex rigida, Good.
C. capillaris, L.
Festuca vivipara.
Woodsia ilvensis, R. Br.

FIG. 13. Denudation of the Peat exposing Glacial Clay on Tynehead Fell at 1,800 feet.

FIG. 14. Alpine plateau, Cross Fell.

Summary.

The following tables give an analysis of the areas covered by the main types of vegetation in Part I. and Part II., and as the area of observation is extended northwards and westwards, such tables will give a ready means of comparing the vegetation of neighbouring districts:—

Sheet I.

		Square miles.		
Cultivation ...	Oats and permanent pasture (O, OPa)	128	...	45½ per cent.
Woodland ...	Deciduous woodland (D, OK, Bi) ...	4	...	1½ „
	Coniferous woodland (P, C) ...	3	...	1 „
Sub-Alpine ...	Natural pasture and grass heaths (Pa, GH, HGH)	62	...	22½ „
Moorlands ...	Heather with Eriophorum moors (EH)	1½	...	½ „
	Heather moors (H)	45	...	16 „
	Sphagnum bogs (S)...	5½	...	2 „
	Eriophorum bogs (E)	12	...	4½ „
Alpine moorlands ...	Vaccinium and Vaccinium and heather moors (V, VH)	17	...	6 „
	Alpine grass heath and pasture (GH, Pa)	2	...	¾ „
	Alpine plateau	trace		
	Total	280		100 „

Total area over 2000 feet, 19 square miles.

Sheet II.

		Square miles.		
Cultivation ...	Oats and permanent pasture (O, OPa)	63	...	22½ per cent.
Woodland ...	Deciduous woods (D, OK, Bi) ...	1	...	½ „
	Coniferous woods (P, C)	3	...	1 „
Sub-Alpine moors ...	Natural pasture and grass heaths (Pa, GH, EGH, HGH, VGH)	89½	...	32¼ „
	Heather moors (H)	25½	...	9¼ „
	Heather with Eriophorum moors (EH)	47½	...	17 „
	Eriophorum bogs (E)	13	...	4½ „
Alpine moorlands ...	Vaccinium and Vaccinium and heather moors (V, VH)	10½	...	3¾ „
	Eriophorum, Vaccinium and heather moors (EVH)	16½	...	6 „
	Alpine pasture and grass heaths (Pa, GH)	10	...	3½ „
	Alpine plateau (A)	½	...	
	Total	280		100 „

Total area over 2000 feet, 41 square miles.

The percentages are expressed per cent. of the total of 280 square miles.

I am greatly indebted to Mr. H. E. Wimperis, B.A., Assoc.M.Inst.C.E., for making these measurements. The figures were obtained by means of a planimeter from the published botanical maps. The error

introduced by the slope of the ground is in all cases quite small, rarely approaching, and never exceeding, 1 per cent.

In conclusion, it may be interesting to compare the two areas of the northern Pennines now surveyed with the southern Yorkshire Pennines surveyed by Messrs. Smith, Moss, and Rankin. The southern district presents a smaller extent of moorland than the northern, and at the same time is intersected by a larger number of cultivated areas. The flat-topped hills are covered with a dominant vegetation of Eriophorum bog, and in most cases only a narrow fringe of heather or grass moorland separates these bogs from the cultivated area.

On the more elevated moors of the northern region the Eriophorum bog is much less in evidence, and in its place we have a great development of heather and grass moorland (22 per cent. of the area) rising above 2000 feet into the upper zone of vegetation. Over much of these Alpine moors on the dysgeogenous hills, Calluna and Vaccinium are dominant plants, but Eriophorum again becomes conspicuous on the eugeogenous Weardale Fells. Well-marked areas have been mapped on Stainmore, where Sphagnum or the bog moss supersedes all other plants, but this association has not been recognized in the South Yorkshire district.

The range of the different associations in Part II. may be summarized as follows:—

I. *Region of Cultivation.*
   1. With oats (no wheat), 450 feet to 800 feet. Only in the Eden valley and lower Weardale.
   2. No oats. Permanent pasture reserved for hay: upper limit, 1950 feet.
   3. Region of deciduous trees: upper limit, 1100 feet.

II. *Sub Alpine Region.*
   1. Region of coniferous trees: upper limit, 2015 feet. Pine-remains in the peat at 2400 feet.
   2. Birch copses: upper limit at the present time, 1200 feet. Extensive birch-wood remains up to 2700 feet.
   3. Grass heaths, generally developed as an intermediate zone between the Alpine moors and the area of cultivation.
   4. Natural pasture developed in patches or long bands on outcrops of limestone.
   5. Heather moors only developed in a few places between the Eriophorum areas and the grass heaths.
   6. Heather with Eriophorum moors covering nearly all the ground immediately below the Alpine moors.
   7. Eriophorum or cotton grass bog in badly drained areas at all altitudes.

III. *Alpine Region.*
   1. Vaccinium and heather moors developed on the dysgeogenous

In Dr. Otto Pettersson's Paper, salinity and chlorine should everywhere read "per mille" and not "per cent."

hills, particularly the Cross Fell range: lower limit, 2000 feet; upper limit, about 2200 feet.

2. Eriophorum, Vaccinium, and heather moors developed on the eugeogenous hills of the Weardale watershed: lower limit, 2000 feet; upper limit, 2300 feet.
3. Alpine grass heath above the Vaccinium and heather moors.
4. Alpine pasture on limestone exposures well developed at Raehow End, on Ousby Fell, and Millburn Forest.
5. Alpine plateau on the more exposed summits.

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ON THE INFLUENCE OF ICE-MELTING UPON OCEANIC CIRCULATION.

By Dr. OTTO PETTERSSON.

The circulation of oceanic waters has been ascribed partly to physical causes, such as the heating of surface waters in tropical and the cooling in polar regions, partly to mechanical causes, such as the influence of the prevailing winds. The latter is at present regarded as the chief motive power of the currents of the sea. In either case the *vis movendi* must be the effect of a thermodynamic cycle of the free heat in the atmosphere or in the hydrosphere. On the mechanical hypothesis, it is obvious that the primary effect is the generation of surface currents (wind-currents) of great intensity, and that the intensity of motion must decrease with the depth.

The general conviction at present is that the movement of the bottom waters of the ocean is extremely slow (*vide* G. Schott's description of the results of the German *Valdivia* expedition).

In 1878 I pointed out that a great—and probably the greatest—part of the oceanic current system must be due to another cause, viz. the thermodynamic cycle of latent heat, consisting in the formation of ice in polar regions, and the melting of ice in sea-water at lower latitudes.*

The melting of ice in sea-water gives birth to a system of currents and undercurrents, of which the following diagram will give a schematic representation:†—

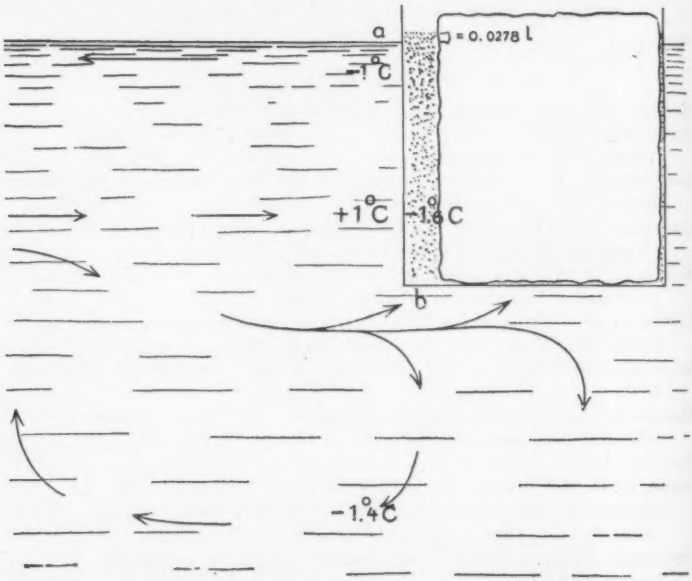

FIG. 1.—SCHEMATIC REPRESENTATION OF THE MELTING OF ICE IN SEA-WATER.

Imagine an ice-block floating in water of +1° C. temperature of 35 per cent. salinity. If the block is of rectangular shape, and its submerged part is L metre in depth, the height of the free part of the ice which rises above the water will be 0·1185L.

Imagine the ice to be enclosed in a thin box of perfectly conducting metal, wherein it melts. If the ice-water is allowed to escape through an aperture at *a*, and the sea-water to enter from below through another aperture in the bottom at *b*, then the ice-water will rise, forced up by the superior hydrostatic pressure of the salt water, and spread over the surface of the sea. The sea-water acts like the piston of a pump, and the work of this pump-stroke we find by an easy calculation to be 0·0139L kilogrammetre for every kilogram of ice melted.

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* *Öfvers. Kgl. Vetenskaps Akademiens Förhandl.*, 1878, No. 2, p. 61; and 'On the Properties of Water and Ice' (Vegaexpeditionens iakttagelser, Stockholm, 1883).

† For the particulars of this deduction, see the paper, "Die Wasserzirkulation im Nordatlantischen Ocean," *Pet. Mitt.*, 1900, Heft. III. and IV., p. 7.

The calculus * shows—

1. That the amount of work set free at the melting of ice in salt water is proportional to the specific gravity of the water. When the density of the water is =1, it becomes nil, *i.e.* the melting of ice in fresh water produces no mechanical effect.

2. That the energy is proportional to the depth of the submerged part. If we calculate the effect of the melting of a kilogram of ice from an Antarctic iceberg

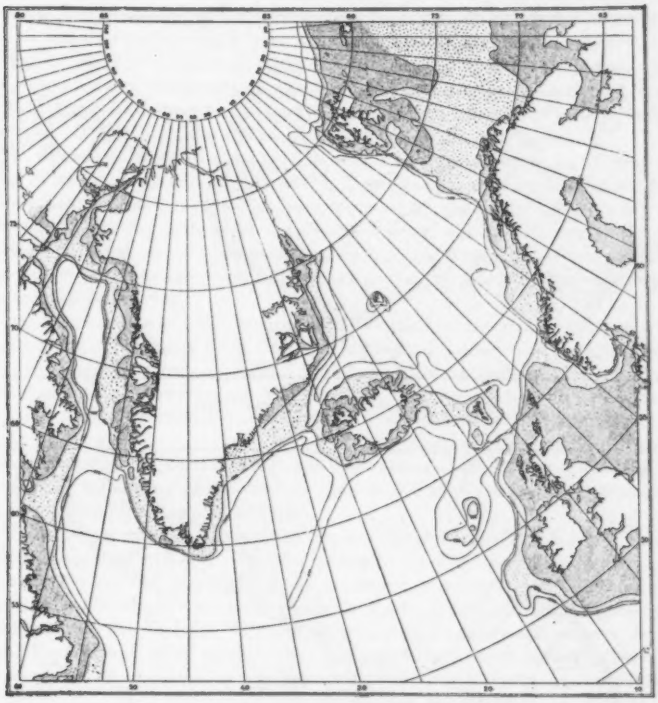

FIG. 2.—BATHYMETRIC CHART.

drawing 500 metres of water, the energy will be equal to about 7 kilogrammetres. The energy stored up in the system ice and salt water is entirely transformed into motion of the water, *i.e.* to the generation of oceanic currents. It is a notable characteristic of the transformations that belong to the cycle of latent heat, that no deterioration or loss of heat takes place.

The heat which maintains the ice-melting process is supplied from the surrounding water, which is cooled to −1·90° C.† in contact with the ice. It

* See *Pet. Mitt.*, 1900, *l.c.*

† According to M. Knudsen's last determinations. See 'Publications de circonstance No. 4 du Conseil permanent international pour l'exploration de la mer.' Copenhague, 1903.

partly mixes with the ice-water, thereby forming a surface current of cold diluted water ("polar" currents). Partly it sinks to the bottom, after having given up its surplus of heat to the ice. This cooled water forms the bottom layer of the oceans. The diagram indicates this system by arrows.

It is evident that the water in the immediate vicinity of the ice cannot maintain the ice-melting process long. The sea-water which has given up its surplus of heat to the ice either ascends or descends, and is replaced by an inflow

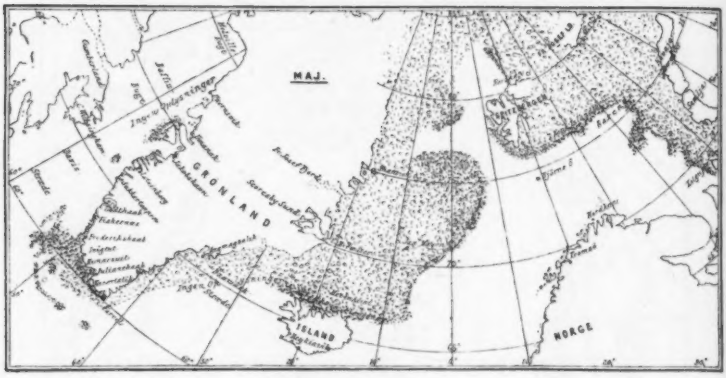

FIG. 3.—ICE-CHART FOR MAY, 1896.

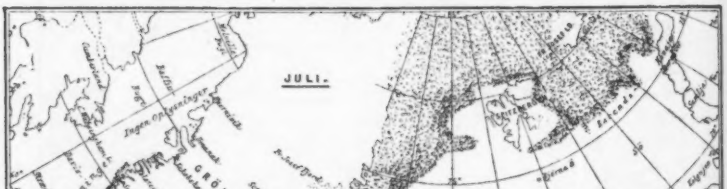

FIG. 4.—ICE-CHART FOR JULY, 1896.

of new water, which necessarily must take the shape of a warmer under-current of what we, in our hemisphere, may denominate as "Atlantic" water between the cold diluted surface layer and the cold bottom layer of "Arctic" water. According to this nomenclature, *Arctic water is mainly Atlantic water which has been metamorphosed by ice-melting.*

In the vicinity of the ice we thus have Arctic surface water (cold and diluted) and Arctic bottom water (cold and very little diluted), and between both Atlantic

water. Every deep sounding hitherto made in the ice-filled regions of the ocean bears out the fact that there exists a maximum of temperature and salinity (not of density) under the ice and waters of the polar current—N.B. if the depth is sufficient to allow the triple system of currents to develop. Wherever the depth is too shallow to permit the warm under-current to enter, the ice of the polar currents is carried unaltered down to lower latitudes. Therefore ice-currents always follow the continental shelf (*e.g.* the coasts of Greenland and Labrador). Wherever an ice-current has to pass over a deep part of the sea (*e.g.* Baffin's bay, south of Newfoundland, etc.), its ice-masses are vigorously attacked by the warm under-currents which always follow the trend of the deepest isobathic lines.* The ice-current dissolves into a cold-water current; or gives birth to a cold-water area which extends over great parts of the ocean. Consequently the ice-melting process in the oceans is localized to the meeting-places of ice-currents with warm under-currents. One such place is the sea between Iceland and Jan Mayen.

From the following sea-chart we infer that a broad channel, up to 1900 metres deep, extends from the deep region of the Norwegian sea between Iceland and Jan Mayen to the coast-bank of Greenland, over which the polar current wafts its icefloes towards the entrance of the Denmark strait, which, at its narrowest part between the north-western promontory of Iceland and Greenland, is very shallow. The ice, crowded together here, finds an escape through the deep channel between Iceland and Jan Mayen.

In March and April the ice-drift usually occupies the greatest part of this channel, and occasionally sends floes and blocks of ice down to the eastern and even to the southern coast of Iceland. Such was the case in April, 1903. In the following months, however, the influence of a warm under-current, a branch of the great Atlantic warm-water current of the Norwegian sea (*alias* "Gulf Stream"), begins to manifest itself by the melting of the ice between Iceland and Jan Mayen. The following charts, borrowed from the publications of the Danish Meteorological Institute, show how an area of not less than 90,000 square miles was cleared from ice in the time from May to July, 1896.

From the excellent hydrographic deep soundings of the Danish Ingolf Expedition, I have calculated the energy generated by the ice-melting in summer between Iceland and Jan Mayen to be equivalent to about 400,000 H.P. It can be resembled to that of a waterfall where the water, instead of descending, ascends from below to the surface. Thereby the waters of a mighty cold-water current, the "East Iceland polar current," are accelerated in a south-easterly direction, contrary to that indicated by the influence of the Earth's rotation, towards the Färoe islands. The velocity of this current was calculated to be 6·9 cm.-sec. (direct measurement by floats indicate a velocity of 8·4 cm.-sec.), and that of the under-current to be 2·9 cm.-sec. in the contrary direction.†

Both currents are represented—the warm under-current by a broad line, the cold surface current by a number of finer parallel lines, on the following chart, which is a schematic representation of the current system of the North Atlantic and the Norwegian sea. Full-drawn lines denote surface currents, dotted lines under-currents.

In the Atlantic proper, south of Iceland, we notice the ramifications of the

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* This tendency of the warm under-currents to follow the deepest troughs of the ocean must be ascribed to the influence of friction. It is obvious that a body of water which moves between two other layers of water in a direction opposite to them must be influenced considerably by friction, and take the line of least resistance.

† This was the number calculated by W. Ekman, *Pet. Mitt.*, *l.c.*

great Atlantic warm-water current. Each of these branches proceeds northwards, following the direction of one of the deep troughs of the Atlantic (cf. the bathymetric chart). Two of these branches enter into the North sea, one through the Channel, the other north of the Orkneys and Shetlands. From the latter an under-current penetrates into the Skagerack over the North sea plateau, following the western and southern side of the Norwegian channel.

Next we have the great warm-water current of the Norwegian sea which enters over the Wyville Thomson ridge, its access to the Norwegian sea over the Iceland-

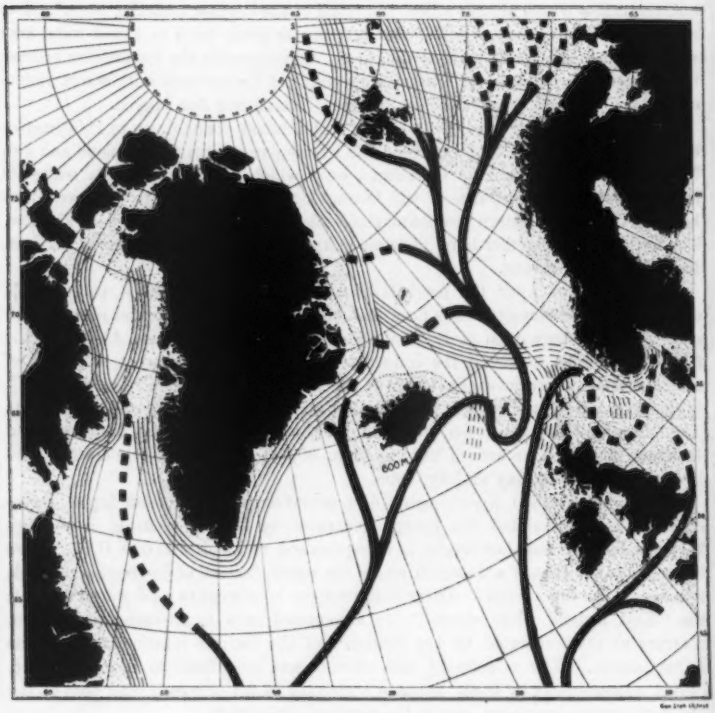

FIG. 5.—NORTH ATLANTIC CURRENT CHART.

Färoe bank being usually stopped by the East Iceland Arctic current (see the chart), which skirts the northern side of this bank, and sends an under-current in the shape of a submarine waterfall over the Iceland-Färoe and Wyville Thomson ridge into the depths of the North Atlantic, and likewise another under-current as an updrift of cold Arctic water over the North sea plateau east of Shetland. A third branch enters through the Norwegian channel into the Skagerack. By the alternate inflow of Atlantic and Arctic water, the fish-life and the distribution of the plankton in our seas is determined.

In the middle part of the Norwegian sea the velocity of the Atlantic current abates, and a great accumulation of warm water of southerly origin takes place which

can attain a thickness of up to 800–1000 metres, according to the deep soundings of Mohn, Nansen, Hjort, and others. The core of this body of Atlantic water was found about 0° long. in the summer of 1900. From this centre under-currents branch off westwards and northwards, always following the direction of the deepest channels of the Norwegian sea. One of these under-currents penetrates into the deep channel between Iceland and Jan Mayen, another takes a north-westerly direction towards the coast of Greenland; the main part of the Atlantic water continues its way northwards west of Spitzbergen, and enters into the deep polar basin, where Nansen discovered it at about 200 metres' depth.

A considerable part of the Atlantic current enters into the Barentz sea between Norway and Beeren island. The chart gives a representation of the current system of this sea according to the recent Russian investigations.*

The branch of the Atlantic current which enters the Barentz sea is the only one that seems to follow the easterly trend imparted to its waters by the Earth's rotation. All the other branches seem to be emancipated from this influence by a stronger attraction acting in the opposite direction. A similar observation can be made with regard to the East Iceland polar current, which takes a south-easterly direction, although it, as a south-going current, ought to show a tendency to keep close to the coast of Greenland. The power which counteracts the influence of the Earth's rotation is the attraction which the ice-melting process that is going on at the western side of the Norwegian sea exerts upon the warm water in the eastern and middle part of that sea. Another example of a north-going current which is deviated westward is the Irminger current south-west of Iceland, and the under-current of Davis strait and Baffin's bay.

Carpenter, from the observations of the *Valorous*,† signalled the existence of a thick layer of relatively warm water in Davis strait up to 63° N. lat. The observations of the Danish cruisers *Hekla* and *Ingolf* corroborate this statement. In 1883, A. Hamberg,‡ hydrographer to the Nordenskiöld expedition to Greenland, proved the existence of a layer of Atlantic water of +0°·4 to +0·9 C. temperature between two ice-cold layers of Arctic water at 400–500 metres as far to the north as 74° and 75° N. lat. in Baffin's bay. For Baffin's bay and Smith's sound we have further evidence of the existence of an Atlantic under-current in the following words of E. L. Moss: §—

"The channels between the polar sea and Smith's sound contain two strata of sea-water not owing their temperatures to local causes—an upper stratum of polar water overlies a warmer northward-flowing extension of the Atlantic."

From the scanty material of trustworthy deep soundings scattered in the enormously vast literature of narratives of Arctic explorations, I have constructed the schematic representation of the current system of the North Atlantic on p. 290.

The irretrievable fact that there exist under-currents of warm Atlantic water in the western tributaries of the North Atlantic bears evidence in favour of the theory here propounded. If there were no other forces in action except the winds, differences of level, of temperature and density, etc., the oceanic circulation in the North Atlantic would assume the regular cyclonic character so elaborately delineated in Mohn's great work.‖ The influence of the Earth's rotation would

* N. Knipowitsch, "Zur Kenntniss der geologischen Klimate," *Verhandl. d. k. Russ. Mineralogischen Gesellschaft*, Bd. xl. 11.

† *Proc. R. Soc.*, vol. 25, 1876–77, p. 230.

‡ *Bih. K. Svenska Vet. Ak. Handl.*, Bd. 9, No. 16, p. 53.

§ *Proc. R. Soc.*, vol. 27, 1878, p. 545.

‖ H. Mohn, 'The North Ocean, its Depths, Temperature, and Circulation.' The Norwegian North-Atlantic Expedition, 1876–78. Christiania, 1887.

keep the north-going Atlantic water at the east and the Arctic water at the west side of the ocean.

A closer inspection of the actual state reveals that there must be a flaw somewhere in the existing theory. If we consider the motion of the surface waters of the Norwegian sea as borne out by the charts of floats set free by the *Ingolf* expedition * and the expeditions of Nathorst,† the buoys of André and others, we find a close resemblance between the tracks of these floats and the current chart on plate i. in Mohn's work. But if we take also into account the qualities of the water in motion, viz. its temperature, salinity, and plankton, we shall find that the main body of Atlantic water does not flow close to the Norwegian coast, not even close to the Norwegian coast bank, but takes a more westerly course, leaving a broad area of water of mixed origin (Atlantic, Baltic, Arctic water + effluvies from the rivers and fjords, etc.) between itself and the Norwegian coast. This area is characterized by *neritic* plankton: *Tripos* plankton Tp (Cleve) in the southern part and North sea; northern neritic plankton Ns (Cleve) in the northern part, while the Atlantic water contains oceanic plankton, *Styli*, *S.*; *Chæto*, *C.*; *Tricho*, *T.* (Cleve).‡

From this body of Atlantic water which, by some influence that counteracts the easterly trend imparted to the water by the Earth's rotation, is deflected to the north-west between 66° and 69° of latitude, the under-currents mentioned on p. 290 branch off in the following directions:—

1. To the west, following the deep channel between Iceland and Jan Mayen.
2. To the north-west towards the east coast of Greenland.
3. To the north towards the north polar basin, following the west side of the coast bank of Beeren island and Spitzbergen.
4. To the east towards Barentz sea.

Each of these under-currents of Atlantic water will be discussed separately in the following. The existence of under-currents of warm water in the North Atlantic can be traced—

At the surface—by great edentations in the ice-filled area of the sea. The great bights in the ice well known to whalers and Arctic explorers are caused by such under-currents. The ice-chart for May, 1896, on p. 288 gives an illustration of this.

At intermediate depths—by the maximum of salinity and temperature, which, as a rule, is found in all deep soundings in Arctic regions between about 60 and 300 metres. From the temperature series of the *Ingolf* expeditions between Iceland and Jan Mayen, and from the discovery of a layer of more than 0° C. temperature under the polar current on the coast bank of Greenland by Captain Ryder, I was led on the track of the two under-currents here enumerated as Nos. 1 and 2. The under-current west of Spitzbergen (No. 3) was discovered by Mohn in 1878. The under-currents of the Barentz sea have been studied most elaborately by the Russian hydrographic commission.

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* 'Den Danske Ingolfexpedition,' i. C. F. Wandel.

† 'Expedition de A. G. Nathorst, Recherches oceanographiques par F. Åkerblom.' Upsala Univ. Arsskrift, 1903.

‡ Cleve in his description of the plankton of the Scottish expedition with the *Research* in 1896, was the first to distinguish the two different plankton areas in the eastern part of the Norwegian sea. His observations concern, however, only the region north of the Wyville Thomson bank. A complete biological survey of the plankton of the surface water of that sea was made in 1900 by J. Hjort and H. Gran (see *Pet. Mitt.*, 1901, iv. pp. 73–83).

At the bottom—by the prevalence of CaO in the bottom deposits. It has been said before that Atlantic water undergoes a metamorphosis in contact with ice, so that Atlantic water which has taken an active part in the melting of polar ice assumes the characteristic properties of arctic water, not only with regard to its temperature, salinity, density, etc., but also with regard to its gaseous contents and the character of its plankton. Sir John Murray has first called attention to the fact that the foraminifers, radiolarians, etc., which form a prominent part of the plankton of the Atlantic water, perish when this water comes into contact

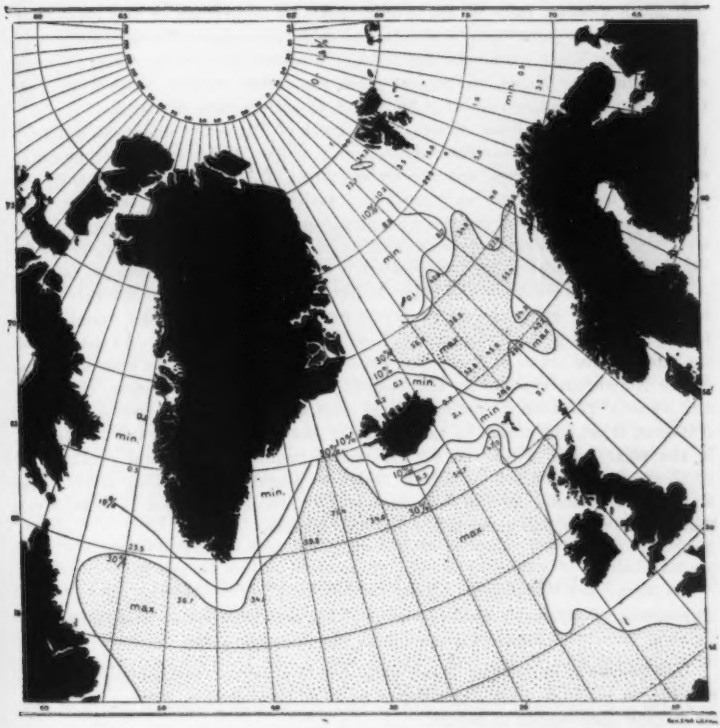

FIG. 6.—CHART SHOWING THE PERCENTAGE OF CaO IN THE BOTTOM DEPOSITS.

with the water of the polar currents. Their calcareous shells then sink to the bottom.

In accordance with this observation, we find, from an inspection of this chart, which I have compiled from the results of the *Challenger*, the *Vörringen*, and the *Ingolf* expeditions, the path of every under-current of Atlantic origin marked out by a relatively high percentage of CaO (above 40 per cent.) in the bottom deposit. All the currents here mentioned, the under-current of Davis strait, the Irminger current west of Iceland, and the under-currents Nos. 1–4 of the Norwegian sea have left their marks upon the sea-bottom in shape of calcareous deposits. Special attention must be drawn to an isolated patch of the bottom at 77°–78° N. lat.

west of Spitzbergen, richly covered with shells of globigerinas, etc., which marks the path of the under-current No. 3 of the north polar basin. On the other hand, we can expect to find the track of arctic currents on the sea-bottom in the shape of characteristic deposits of silicious ooze and clay, since the main plankton of the Arctic water consists of diatoms, *Sira-plakton*, *Si* (Cleve). The excellent chart of the bottom deposits of the Norwegian sea, drawn by the chemist of the *Vörringen* Expedition, Mr. Schmelck,* is an illustration of this.

In the preceding I have shown that under-currents of Atlantic water can, in spite of the influence of the Earth's rotation, be deflected to the remotest western and north-western parts of the Arctic ocean by the energy of the ice-melting process. By the same agent currents and under-currents of Arctic water can be deviated from their course and directed to the eastern side of the ocean. Among such currents we notice, in the first place, the surface current which flows along the eastern and southern coasts of Iceland in an anti-cyclonic direction.

The East Iceland polar current which north of Färoe dips under the waters of the Atlantic current is another example (see p. 289). A close connection seems to exist between this current and the under-current of Arctic water which from the depths of the Norwegian sea penetrates into Skagerack through the Norwegian channel. As we may infer from the current chart on p. 290, Skagerack receives also an inflow of Atlantic water over the North sea plateau, which likewise arrives in the shape of an under-current, the surface of Skagerack being—at least in summer—covered by the waters of the Baltic current emerging from the Kattegat. This triple system of currents—which furthermore is liable to periodic variations—makes the study of the hydrography of our seas very complicated. At the time of the international cruise in November, 1903, the water-layers of the innermost part of the Norwegian channel in the Skagerack, from 30 to 300 metres, contained a rich animal plankton consisting of large crustaceans of the same species found by Nathorst, Hjort, and others in the depths of the Norwegian sea, and by Nansen in the polar basin, while the surface waters teemed with vegetal plankton of southern origin: southern neritic or *Didymus* plankton, *Di* (Cleve), mixed with a species of diatom, *Biddulphia chinensis*, known from tropical or subtropical parts of the ocean, and never before found in our seas.

Experiments with Ice-melting in Sea-water.

Application of Bjerkne's Hydrodynamic Theory—The General Outlines of the Oceanic Circulation in the Norwegian Sea.

The process of ice-melting in salt water can be studied experimentally, and it is possible to conduct such experiments so that they have a bearing upon the ice-melting phenomenon in nature.

First I will describe some very simple lecturing experiments which can be projected upon a screen in order to give a general idea of the different system of currents generated by ice-melting in fresh water and in sea-water.

A small parallelopipedic tank with transparent sides is filled with water. Five glass tubes, each containing a fragment of a crystal of permanganate of potassium dip into the water, each giving birth to a tiny jet, intensively coloured, which descends perpendicularly to the bottom. Now introduce a small piece of ice at one side of the tank. The image which appears upon the screen will be very different if the experiment is made with fresh water or sea-water. In both cases the jets are deflected towards that side of the tank where the ice is placed. The

* 'The Norwegian North Atlantic Expedition, 1876–78,' Chemistry, i.

characteristic features of each series of experiments is, that there is no trace of an outgoing surface current in fresh water which appears very distinctly in salt water.

In fresh water we observe the usual convectional currents which appear in every liquid when cooled or heated; the water sinks at the cooled side of the tank and rises at the other. In salt water the currents have the appearance shown in the following figure:—

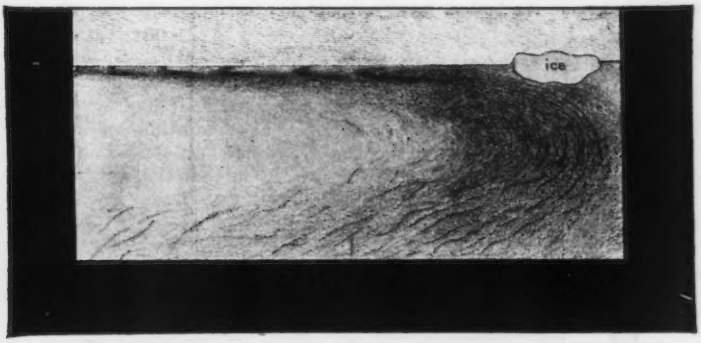

FIG. 7.—ICE-MELTING EXPERIMENT.

We can discern three different currents: one on the surface, which flows from the ice; another current at intermediate depth runs straight towards the ice; while a third current, consisting of water cooled by contact with the ice, follows the bottom of the tank. The triple-current system in our tank represents the polar current, the under-current of Atlantic water, and the cold bottom water of the western parts of the Norwegian sea. Analogies of this kind invited to further experiments combined with quantitative determinations. The essential condition for obtaining quantitative measurements was, however, to establish a stationary system of currents. For this purpose it became necessary to provide for an unlimited supply of ice and of sea-water of constant temperature and density.

Moreover, it became desirable to make an alteration in the outfitting of the tank, in order to realize as much as possible in an experiment the peculiar hydrographic conditions of the North Atlantic and the Norwegian sea. The characteristic feature of these seas is the submarine ridge between Iceland, Färoe, and Scotland, whereby the northern part of the Atlantic is divided into two deep basins. The tank was consequently divided into two compartments by a partition shown in the following figure (p. 296). In the outer (Atlantic) compartment an extra current of sea-water of the same temperature and salinity was allowed to circulate with constant velocity. At the end of the inner compartment was placed a cage of galvanized iron wire containing ice. At four places indicated by vertical lines in the figure, the temperature, salinity, and density of the water at 2, 4, 8, 12, and 16 cms. depth was determined.

The contrivance used for this purpose, a sledge with cog-wheels, pipettes, thermometers in the shape of an L, need not be described here. The water was purposely not filtered. By observing the motion of the small particles held in suspension by the water, I was able to estimate approximately the velocity of the currents at different depths. The experiment was made in the great cellar vault of the laboratory, where the temperature was almost constant. The sea-water

(about 30 litres) was kept in a wooden barrel, and carefully stirred before the beginning of the experiment. The initial temperature was = 5°·52 C., salinity = 33·45 per cent. Before the introduction of ice, the extra current was allowed to flow regularly for two hours through the outer compartment with a velocity of 0·7 cm. to the second. This circulation caused little or no motion of the water in the other compartment. After the introduction of the ice, the formerly stagnant waters of this compartment began to flow with considerable velocity; the surface water and the bottom layer *from* the ice, the intermediary layer *towards*

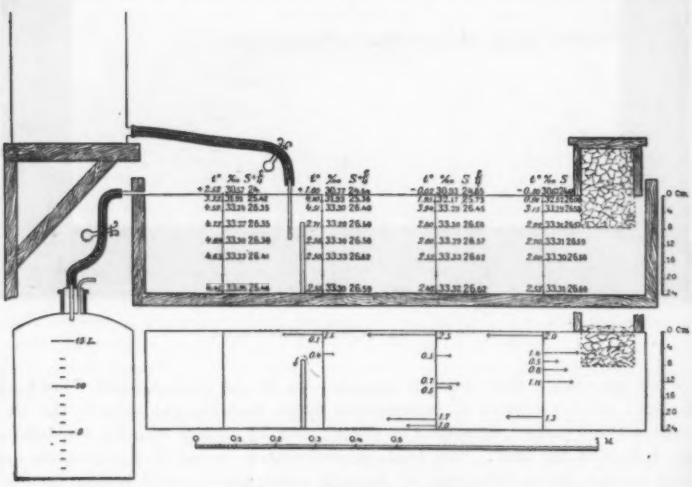

FIG. 8.—ICE-MELTING EXPERIMENT.

the ice. In a second experiment a sponge with a few crystals of malachite-green was fastened before the orifice of the tube, in order to make the course of the extra current visible. So long as there was no ice in the inner compartment, the water there was clear and transparent unto a few centimetres from the partition, while the waters of the outer compartment were intensely coloured. With the introduction of the ice the state of things was changed. The water of the extra current was deflected to the right in the shape of a well-defined under-current, which passed about 1 cm. over the partition wall straight towards the ice. Here the coloured tongue of water parted in two, one part rising to the surface, where a rapid current, flowing at the rate of 2 cms. to the second, brought the water back to the outer compartment and to the exit tube. The other part sank down from the ice to the bottom. The bottom water flowed towards the wall, where it seemed to accumulate until it reached the level of the partition and found an escape over it into the outer compartment under the ingoing current—a striking illustration of the description * of the outflow of the waters of the east Iceland polar current over the Färoe-Iceland and Wyville Thomson submarine ridge *under* the Atlantic current, which runs in the opposite direction over the ridge into the Norwegian sea.*

The rising tendency of the bottom water at the right side of the submarine

*. See M. Knudson, 'The Danish *Ingolf* Expedition.'

ridge is proved by its relatively low density (1·02659) at 24 cms. depth. At 16 cms. the density of the water *in situ* was found to be 1·02662. The observations in the vicinity of this place are too few to admit a calculation of the dynamical conditions; but it nevertheless seems probable that in similar places in the ocean—*e.g.* at the northern side of the Wyville Thomson bank—the motion of the deep water takes the shape of a vertical vortex or eddy.

The influence of the cold under-current which passes over the ridge is shown by the lower temperature 4°·45 C., and the higher density 1·02645 at the bottom of the other compartment. The cold under-current which passes over the Iceland Färoe bank has a similar effect upon the temperature of the bottom water on the Atlantic side of the bank, according to M. Knudsen.

The numbers in the diagram on p. 296 refer to measurements made eight hours after the introduction of ice in the second compartment, when the triple current system had become stationary. The maximum of temperature corresponding to that which characterizes Arctic seas was situated at a depth of 4 cms. in the two "stations" nearest to the ice. The temperature series from the "stations" in our experiment has a striking analogy to certain well-known temperature series obtained by deep soundings in Arctic and Antarctic seas. See the diagram, Fig. 9.

The only essential difference is that the temperatures in the experiment on the

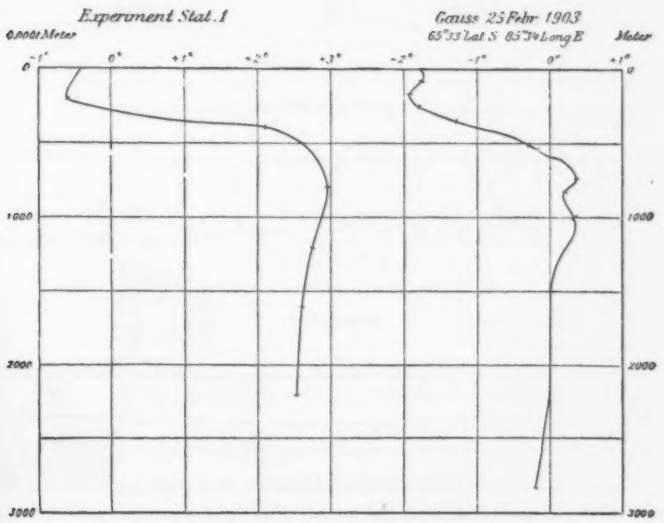

FIG. 9.—TEMPERATURE DIAGRAMS.

whole were found to be higher than in the deep soundings. We must remember that the temperature depends (1) upon the distance from the ice, (2) upon the rate at which the supply of warm water to the ice takes place. If the extra current in our experiment had flowed less abundantly, we should have attained a temperature series similar to those observed in the ocean, but in that case it would have lasted weeks before the stationary state had been reached. From the experience now gained, I felt convinced that it would be possible to conduct an experiment in

such a manner that it would present a stringent analogy to the ice-melting phenomenon in nature, and open the way for mathematical discussion of such phenomena. The theoretical problem can be attacked from two sides, viz. from a thermodynamical or from a hydrodynamical point of view. In my former paper in *Petermanns Mitteilungen* I had, from elementary thermodynamic principles, calculated the energy developed by the ice-melting process in summer between Iceland and Jan Mayen, which maintains the East Iceland polar current, to be about 400,000 H.P. This time the problem seemed to fall more within the

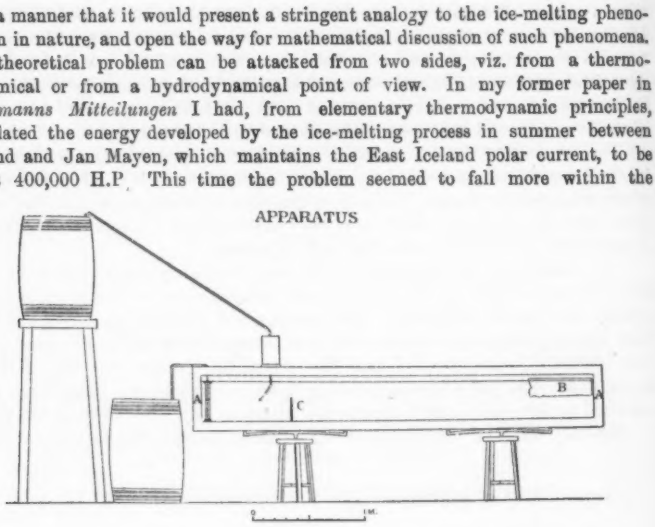

FIG. 10.—ICE-MELTING EXPERIMENT (KRISTIANIA).

limits of hydrodynamics, since the object was to locate the accelerating forces of the oceanic circulation of the North Atlantic. For such purpose I requested Mr. J. W. Sandström, First Assistant to the Swedish Hydrographic Commission, to repeat the experiment on a larger scale in the Central Laboratory for Oceanic Research at Christiania with a large tank, which Prof. F. Nansen kindly placed at my disposal, in such a manner that the result could be calculated according to the principles of Prof. W. Bjerknes' hydrodynamic theory.* In the analytical

* V. Bjerknes, "Ueber einen hydrodynamischen Fundamentalsatz und seine Anwendung auf die Mechanik der Atmosphäre und des Weltmeeres," *K. S. Vet. Ak. Handl.*, Bd. 31., 1898.

work, Mr. Sandström was assisted by our chemical assistant, Miss A. Palmquist. The particulars of this experiment will be described in a separate paper. Mr. Sandström, who employed an extra current of less intensity than I had used, was able, on account of the larger scale on which he operated, to study the ice-melting phenomenon in the immediate proximity of the ice. He found that the accelerating forces generated by the melting of the ice are very intensive, and tend to establish the triple-current system which I have described. According to Bjerknes' theory, we can easily determine the magnitude of the accelerating forces in action within the tank (as well as within the ocean), by computing the number of c.g.s.

ISOHALINES

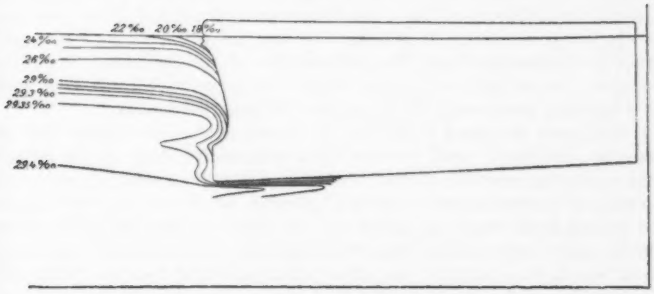

FIG. 11.—ISOHALINES IN THE VICINITY OF THE ICE.

VELOCITY

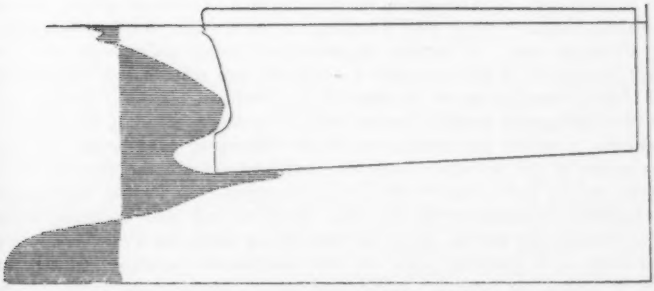

FIG. 12.—VELOCITIES MEASURED IN THE VICINITY OF THE ICE.

solenoids formed by the intersection of the isobathic and isosteric lines of a section through the tank. Calculus shows that within the longitudinal section of the tank shown in the following figure there were two principal fields of forces—one under the ice accelerating in this direction ↻ (= 0·57 c.g.s. solenoids), the other at the opposite side in the vicinity of the partition accelerating in the opposite direction, ↺ (= 0·18 c.g.s. solenoids). The mechanical energy developed by the melting of ice in sea-water consequently tends to generate a current of water cooled by contact with the ice along the bottom of the tank to the partition.

The maximum velocity of this current Sandström measured as 0·14 cm. to the second. The accumulation of bottom water at the partition counteracts the influence of the ice-melting process, the active force being, however, superior to the reactive by 0·39 c.g.s. solenoids. Consequently the bottom water must be carried out of the compartment in the shape of an under-current over the partition wall.* The other currents constituting the triple system were found to be well developed; the outgoing ("polar") current had a velocity of 0·03 cm., the ingoing ("Atlantic") current a velocity of 0·23 cm. to the second.

Mr. Sandström paid special attention to the distribution of temperature, salinity, and density in the immediate vicinity of the ice, as well as to the corrosion of the ice-block, which originally weighed 50 kilos. The following figures show the shape of the ice-block after twenty-four hours. The upper figure represents the isotherms of the water in contact with the ice. The lower figure is a diagram of currents. It will be seen that the action of the warm under-current is concentrated upon the under-surface of the ice-block. For further particulars I must refer to Mr. Sandström's own paper, which will soon appear in the reports of the Swedish Hydrographic Biological Commission.

I next tried to collect a material of hydrographic observations from the Norwegian sea which could be used for a comparative study of the influence of the ice-melting upon the circulation of that part of the ocean. I deemed only such series of observations to be worthy of attention *which were made after modern exact methods in the same year and in the same season of that year.* To combine indiscriminately recent and old deep soundings from many different years into one section, would, on account of the utterly changeable and instable hydrographic state of the Norwegian sea, on which I shall have to speak later, lead to mistakes.

The first year from which we have observations of the sort I wanted, made over a sufficiently large area of the Norwegian sea, is 1900. In that year Prof. Nansen and Dr. J. Hjort made their first cruise with the *Michael Sars.* In the same summer a Swedish expedition, under Mr. Kolthoff, visited the eastern part of Greenland. Dr. Oestergren, the biologist of Kolthoff's expedition, promised to make a couple of exact deep soundings in the ice-filled north-western part of the Norwegian sea. I likewise requested our former assistant in marine research, Captain S. Nilson, to make a couple of deep soundings in the southern part of the Norwegian sea on the slope of the North sea plateau. Nansen and I had then begun, with united efforts and with the technical aid of L. M. Ericson, in Stockholm, to perfect the construction of the Pettersson water-bottle. The first instruments of the new model were used that year on board the *Michael Sars* by Nansen, and on board the *Frithiof* by Dr. Oestergren. To Captain Nilson I left an excellent instrument of the old type, which he had used frequently during our previous cruises and on board his own fishing-vessel, the *Patterdale.* As all these ships were provided with the best instruments existing, and care was taken to ensure the greatest possible accuracy in observing and analyzing, the following longitudinal section will be of special interest combined, as it is from—

Oestergren's deep sounding,	July	8, 1900	...	77° 11′ lat. N., 0° 55′ long. W.
Nansen's "	"	Aug. 11, 1900	...	69° 32′ lat. N., 5° 13′ long. E.
" "	"	July 24, 1900	...	63° 50′ lat. N., 1° 20′ long. W.
Patterdale "	"	" 2, 1900	...	60° 40′ lat. N., 2° 43′ long. W.

* The interesting question, What would happen if the wall was so high that the under-current could not pass over it? will be discussed later.

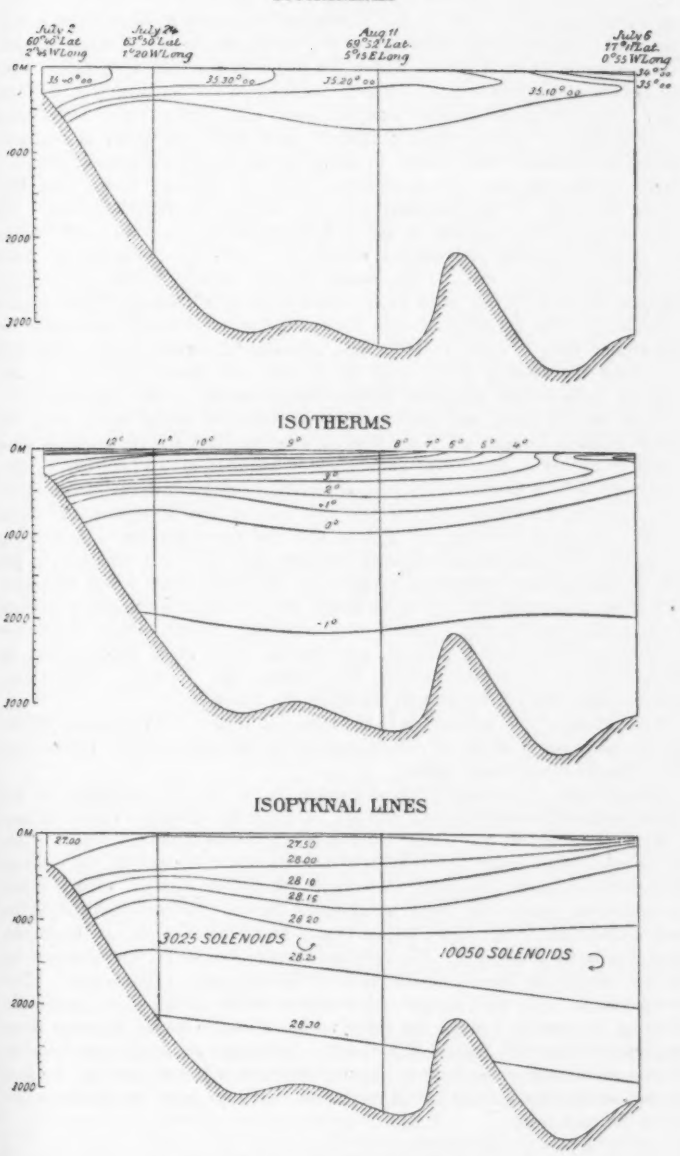

FIG. 13.—LONGITUDINAL SECTION, NORWEGIAN SEA, 1900.

This section bears a striking resemblance to the experiment (see p. 298). The trend of the isotherms indicates the existence of an under-current of warm Atlantic water from the central part of the Norwegian sea towards the ice off Greenland's east coast. At 200 metres under the ice Mr. Oestergren found the usual temperature maximum to be $+1°{\cdot}04$. Above the region of maximal temperature there was the cold and diluted water of the polar current, $t = -0°{\cdot}03$, salinity = 33–34 per cent. From 400 to 500 metres Oestergren found cold bottom water (temperature at the bottom = $-1°{\cdot}23$), which is Atlantic water which has given up nearly all its disposable store of heat in order to maintain the ice-melting process, as will be shown by the diagrams, which represent (1) the isohalines, (2) the isotherms, (3) the isodenses of the sea-water from 77° lat. to the Shetland bank. The principal field of force is found in the vicinity of the ice, *i.e.* at the north-western side of the Norwegian sea, where a number of 10,500 c.g.s. solenoids are found to exist between 70° and 77° lat., accelerating the motion in this direction, ↄ. Between 64° and 70° lat. 3025 c.g.s. solenoids are found, acting in the opposite direction, ↄ. The accelerating force which maintains the oceanic circulation in this section thus is equal to 7025 c.g.s. solenoids* ↄ, which force is sufficient to increase the velocity of the water by 14 cms. per second in one week, the influence of the friction and of the Earth's rotation not being taken into account.

This field of forces will tend to carry a current of cooled water along the bottom of the Norwegian sea to the Wyville Thomson bank and the northern slope of the North sea plateau. The surface water will also have a tendency to flow southwards, and, on account of its inferior density, to spread over the surface of the sea. The diagram shows that the principal field of force is immediately under the ice. We must, however, bear in mind that the above calculus of the existing forces, viz. 7025 c.g.s. solenoids ↄ, only indicates that there is a tendency in the bottom water to flow southwards towards the suboceanic ridge which forms the limit of the Norwegian sea, but by no means can be considered to give a measure of the actual velocity and direction of the issuing current, which, beside the accelerating forces here mentioned, also depends upon other circumstances, as the influence of the Earth's rotation, the friction, etc. Nothing, except actual measurements with current-meters, can settle this question.

The outlines of the circulation in the main part of the Norwegian sea will be clearly understood from the previous discussion of the hydrographic section from 1900. See also the current chart.

The principal *vis movendi* of the circulation is the ice-melting process in the western and north-western parts of the sea. Here in the vicinity of the ice-masses of the polar current we find located the accelerating forces of the circulation which tend to send Arctic water in two different currents, one at the surface, the other at the bottom, to the east and south. The upper one of these currents, usually called "polar current," sends one branch southwards through Denmark strait along the coast of Greenland, where its ice-masses remain nearly intact so long as the current keeps close to the coast bank. West of Cape Farewell the ice becomes scattered by the influence of the warm under-current in the deep part of Davis strait. The second branch is the East Iceland polar current, which divides in two parts, one following the coast of Iceland, the other taking a south-easterly direction along the northern side of the Iceland-Färoe bank. Both parts are usually free from ice, at least in summer, on account of the under-current of warm water in the deep channel between Iceland and Jan Mayen. But there are great exceptions to this rule in different years.

* See Sandström's paper, "An Experiment on the Melting of Ice in Salt Water," *Reports of British Association*, Section E. Southport, 1903.

In certain years—known as ice years in Iceland—that island is surrounded by drifting ice-masses even in summer. The last year when this took place to an unusual extent was 1902. Mr. H. N. Dickson * mentions that in 1902 a block of ice was found drifting in the sea so far to the south as south of the Hebrides, near the Trishinish islands. It must have belonged to the East Iceland polar current. There seems to be no other explanation of such phenomena than to admit the possibility of great variations from one year to another in the inflow of Atlantic water into the Norwegian sea and in the development of the under-currents of warm water in that sea. That such variations take place in the Atlantic surface water I have demonstrated in a previous paper.

The third branch of the polar current is found to the north-west of Jan Mayen. Its course is marked by a great tongue or wedge of pack-ice in the ice-charts, protruding from the north-east part of Greenland (see the ice-chart for May and July on p. 288). From recent deep soundings made in this region of the sea by Ryder in 1891–92, and by Captain R. Amundsen in 1901, we infer that there is no under-current of Atlantic water to be found *under* the ice-filled area of this branch, but on either side of that area we find great bights or indentations in the ice-charts, which are caused by warm under-currents, one flowing to north-west north of Jan Mayen, the other flowing northwards west of Spitzbergen. The diluted Arctic surface water, which is produced by the melting of this ice, spreads widely over the surface of the Norwegian sea, especially in winter, when the greater part of the Norwegian sea is covered with diluted ice-cold water.† Thereby the area of warm Atlantic water in this sea is considerably diminished during the colder season of the year. The chief cause of this phenomenon is that the Atlantic water becomes denser than the Arctic surface water when cooled beyond +4° C. The inundation of the Atlantic water by Arctic water from the west may even go so far that the warm area of the Norwegian sea is divided in two, as I have shown was the case in March, 1898, from the observations of two whalers.‡ The "weak point" of the Atlantic current in winter seems to be situated about 65° N. lat.

The comparatively thin sheets of Arctic surface water contained in the named branches of the polar current are, however, insignificant if compared with the great masses of water which sink to the bottom after having given up its heat to the ice, there to form an under-current which banks up against the eastern and southern limits of the Norwegian sea, filling its deep recesses with a layer of cold Arctic bottom water—the coldest which is known to exist in any part of the oceans of the globe, its temperature being about −1° C. in the southern and −1°·3 C. in the northern part of the Norwegian sea. The deep trough of this sea is brimful of such water up to the niveau of the submarine banks between Iceland, the Färoes, and the Shetland islands. The incessant supply of such cold bottom water generated by the ice-melting in the western and north-western parts of the Norwegian sea causes an outflow in the shape of under-currents to take place—

1. Over the Färoe-Iceland bank. See the diagram on p. 304.§

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* H. N. Dixon, "The Hydrography of the Færoe-Shetland Channel," *Geographical Journal*, April, 1903, p. 13.

† See *Pet. Mitt.*, *l.c.*

‡ This statement, which at first was advanced only as a theoretical consequence of the ice-melting theory, was in the beginning much contested. Dr. H. Gran, however, from observations collected by Dr. J. Hjort in 1897 and 1898, has found that "the Arctic water in March, 1898, and possibly in 1897, reached so far that it overflowed the Gulf Stream for a short distance in about 65° lat. N."

§ Thor's section on Fig. 14 is an illustration of this fact. The diagram represents a section across the Färoe-Iceland bank (see the *Bulletin* for August, 1903, of the

2. Over the Wyville Thomson bank.

3. Through the Norwegian channel into Shagerack and Kattegat.

The named supply of cold water causes an updrift of Arctic water over the northern slope of the North sea plateau, where it mixes with the warm Atlantic water which flows into the Norwegian sea between Scotland and the Färoes, and by the influence of the Earth's rotation is deflected eastwards.

These hydrographic conditions exercise the greatest influence upon the fish-life of the Norwegian sea and North sea. For what we know at present of this subject we are chiefly indebted to the researches of Dr. J. Hjort. The brilliant results obtained by Hjort during his cruises in 1900–1903 with the *Michael Sars*

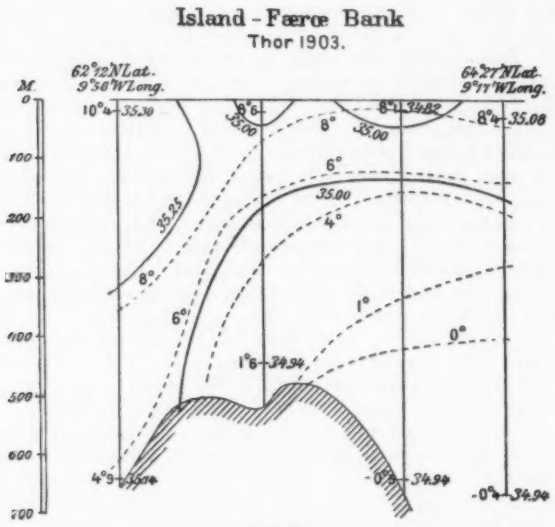

FIG. 14.

are not yet published in detail. From his preliminary reports,* we infer that the hydrographic limit between the cold bottom water and the upper layer of Atlantic water is also a biological limit between an Arctic and an Atlantic fauna of fishes. Below 600 metres the trawl brought up Arctic species of fishes; from that depth the coast banks abounded in the ordinary eatable fishes of our seas—cod, ling, halibut, herrings, and others. There can be no doubt that the bathymetric limit of this fish-life, found by Dr. Hjort, is determined by the level of the submarine

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International Investigation of the Sea, Pl. iv.). On the right (northern) side of the bank we find the isohalines and isotherms of the Arctic bottom water of the Norwegian sea rising up to 200 metres from the surface. In another diagram on the same plate of the *Bulletin* is represented a section along the bank. At the deepest niveau north-west of the Färoes, the isohalines and isotherms of the outflowing Arctic under-current appear.

* J. Hjort, "Die erste Nordmeerfahrt des Norwegischen Fischerdampfers *Michael Sars* im Jahre, 1900," *Pet. Mitt.*, 1901, iv. pp. 73–83. *Vide* also Dr. Hjort's latest Reports to the Norwegian Government.

banks between Iceland and Scotland, which permits the Arctic water to escape into the Atlantic at about 500 to 600 metres' depth from the surface.

According to Hjort, this fish-life is not bound to the coast banks only. From the upper niveaus of the great body of Atlantic water in the Norwegian sea, the angle-lines and drift-nets of the *Michael Sars* brought up cod and herrings, and from the deeper layers of 400 to 600 metres, fishes such as Sebastes, and others.

Not less interesting are the results of the Norwegian cruises with regard to the distribution of plankton, of fish larvæ and eggs, of jellyfish, salpæ, etc., in the surface water. In July and August, 1900, the different areas of water of Atlantic and Arctic origin, as well as the littoral waters west of Norway, were as sharply defined in a biological as in a hydrographical sense. Special interest is attached to the broad area of littoral water of 34 per cent. up to 35 per cent. water west of the Norwegian coast. I consider this water to be formed in the same way as the waters of one part of the North sea, viz. by the updrift of Arctic bottom water, which banks up against the slope of the Norwegian coast bank as well as against the slope of the North sea plateau, and is mixed there with the waters of the fjords, the Baltic current, and Atlantic water. My reason for this supposition is chiefly the close resemblance of the plankton of the coastal waters of Norway with the ruling planktontype of the North sea (Cleves "Tripos-plankton"). Moreover, Hjort has pointed out that the fish fauna of the eastern, southern, and south-western coast-banks (Norway, Shetland, the Färoes to Iceland) has the same general character, although certain species may occur more abundantly in different localities (as, *e.g.*, cod at the northern coast banks of Norway, ling on the Shetland bank, halibut on the banks discovered by Hjort north of the Färoes, etc.).

The Tributaries of the Norwegian Sea.

Experiments upon ice-melting under a limited supply of warm sea-water—The hydrographical state of the ice-fjords of Greenland, of the north polar basin, of the Barentz sea, and of the North sea, the Skagerack, Kattegat, and the Baltic.

In order to demonstrate the hydrographic conditions of the Norwegian sea and North Atlantic, I am obliged again to refer to the experiment with the tank described on p. 295. In this experiment the ice-melting process was maintained at the cost of the heat stored up in the water of the under-current which penetrated into the inner compartment over the partition—the under-current derived from the extra current which circulated through the outer compartment. What would happen if the supply of warm water from that compartment was diminished or cut off altogether? We might realize this in our experiment in two different ways: either by making the partition higher, so that there was little or no space left for the under-current to pass over it between the outgoing surface current and the likewise outflowing cold bottom water, or by stopping the extra current. Such an experiment might serve to elucidate the hydrographic conditions of certain fjords of which the deep inner basin is more or less cut off from free communication with the sea by a submarine ridge at the outlet, or of very remote parts of the sea into which the Atlantic water enters sparely or in indirect ways.

The simplest experimental arrangement of this kind which I could imagine was to dispense altogether with the partition, and study the melting process of a large mass of ice (half a ton) placed in a big aquarium, shown in Fig. 15, containing 12 cubic metres of sea-water.

In the figure is represented the distribution of temperature in the water four

hours after the ice had been introduced. The initial temperature of the water after careful stirring was 6°·38 C., the temperature of the air was 6°·1 C. Arrangements had been made for taking water samples and temperature observations at four "stations" from the surface to 120 cms. depth.

The displacement of the immersed part of the ice was 130 litres. After this quantity of water had left the aquarium, the effect of the ice-melting process began to appear in the shape of a continual outflow from the outlet. The outflowing water was measured and analyzed. The salinity of this water was, during the first four hours, found to be on the average nine-tenths of the original.

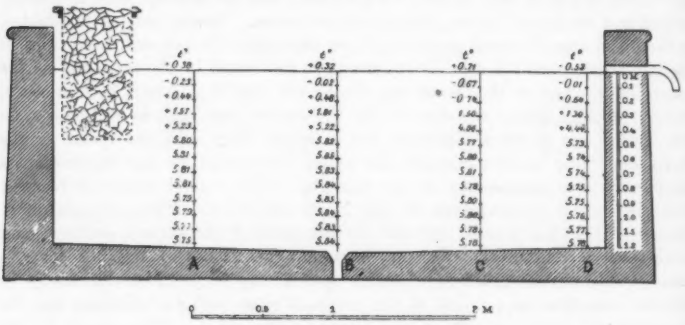

FIG. 15.—ICE-MELTING EXPERIMENT.

The quantity of the outflow diminished gradually in the same measure as the heat stored up in the upper layers was consumed by the ice. During the first four hours the debit from the outlet was 750 c.c. in the minute. After four hours it was 404 c.c., after three days 83 c.c., after five days 50 c.c. in the minute.

From the temperature series * taken at the four stations after the first four hours of the experiment, we can draw the important conclusion that the entire mass of water from the surface to the bottom takes part in the ice-melting process. There is, however, a great difference between the heat debit of the upper layer from the surface to 50 cms. depth, which is in niveau with the ice, and that of the bottom water under the level of the ice from 50 to 120 cms.

In the upper layer the temperature and salinity decreases rapidly. This decrease begins at the surface and proceeds downwards. After four hours the decrease of temperature in the different water-layers was as follows:—

From	0 to 10 cms.		$\triangle t = 6°{\cdot}30$	$\triangle Q = 4{,}337{,}740$	calories.
„	10 „ 20 „		„ $= 5°{\cdot}83$	„ $= 4{,}014{,}130$	„
„	20 „ 30 „		„ $= 4°{\cdot}82$	„ $= 3{,}318{,}710$	„
„	30 „ 40 „		$= 1°{\cdot}39$	„ $= 957{,}050$	„
„	40 „ 50 „		„ $= 0°{\cdot}60$	„ $= 413{,}120$	„
„	50 „ 60 „	under the ice	„ $= 0°{\cdot}58$	„ $= 399{,}340$	„
„	60 „ 70 „		„ $= 0°{\cdot}58$	„ $= 399{,}340$	„
„	70 „ 80 „		„ $= 0°{\cdot}58$	„ $= 399{,}340$	„
	80 „ 90 „		„ $= 0°{\cdot}58$	„ $= 399{,}340$	„
„	90 „ 100 „		„ $= 0°{\cdot}58$	„ $= 399{,}340$	„
„	100 „ 110 „		„ $= 0°{\cdot}58$	„ $= 399{,}340$	„
„	110 „ 120 „		„ $= 0°{\cdot}60$	„ $= 413{,}120$	„

* Dr. F. Åkerblom, then Assistant to the Swedish Commission, kindly assisted me in making these rather troublesome observations.

The upper stratum from 0 to 50 cms. had thus contributed with 13,040,750 calories, and the undermost layer from 50 cms. to the bottom with 2,891,600 calories, to the ice-melting process. All in all, 15,932,350 calories had been given off from the water during the first four hours of the experiment. This agrees fairly well with the amount of latent heat which must have been absorbed by the ice in melting.*

The regularity with which the heat is given off, and the uniformity of temperature which prevails in the deeper water-layers under the niveau of the ice, are highly remarkable.

It seems probable that the circulation of the water-strata in niveau with the ice is kept up by means of horizontal currents of the usual kind that ice produces in sea-water, while the circulation in the water under the ice is effected by vertical convectional currents, *i.e.* by the sinking of water-particles cooled in contact with the cold water of the upper layer and the rising of warmer water from the bottom. I could not directly observe the movement of the waters in this experiment as in the others, because the walls were not transparent, but I think that the extremely regular debit of heat from the deeper strata can best be accounted for by the explanation here given. The determinations of salinity show that, while the salinity of the upper layer is very much reduced by the influence of ice-melting, the decrease in salinity of the bottom water is very little. After twenty-one hours the salinity at 20 cms. had sunk from 24·77 per cent. to 21·91 per cent.; at 60 cms. it was found to be 24·61 per cent.

The whole process thus tends to produce a layer of water of low temperature and salinity of the same depth as the ice, and another layer of very uniform temperature and salinity beneath it. The characteristic features of the ice-melting phenomenon under the conditions given, viz. unlimited supply of ice and limited supply of sea-water, are the following:—

1. The maximum of temperature and salinity which is found immediately under the cold upper layer in Arctic seas, where under-currents of warm water have free access, does not exist.

2. The slow, gradual decrease of temperature, which is found in the deepest layers of Arctic seas, does not exist.

3. The entire mass of water gives off heat to the ice, the upper layer rapidly, the lower indirectly and at a slower rate. Thus, ice floating on a layer of ice-cold fresh or brackish water will slowly melt at the cost of the heat stored up in an underlying stratum of warmer and salter sea-water.

These rules have a direct bearing upon the hydrographic conditions of the ice-fjords of Greenland, as will be seen from the following diagram (Fig. 16).

The figure represents a longitudinal hydrographic section of the great Arsuk fjord at 60° 42′ N. lat., 46° long. W. The interior basin of the fjord is about 600 metres deep, and is separated from the deep water of Davis strait by the coast bank, which probably is about 100 metres deep. At the inner end of the fjord, one of the great glaciers of Greenland dips its ice-masses in the salt water of the fjord to a depth of 100 to 200 metres. A. Hamberg† made an hydrographic investigation of this fjord in 1883, and found the situation as shown in the preceding diagram. There were two layers of water, the upper holding

* The quantity of water which had left the exit tube during the said time was 193 litres, which is equivalent to 193 kilos ice, which absorbs 15,440,000 calories in melting.

† "Hydrografisk kemiska iakttagelser under den Svenska Expeditionen till Grönland, 1883," *Bih. S. V. Ak. Handl.*, Bd. 9, No. 16, pp. 44–49.

32 and 33 per cent. of salt, the undermost 34 per cent. The upper layer from 0 to about 200 metres was, with the exception of the surface water, which was heated by the sun up to 7° C., very cold (−0°·2 to −0°·6 C.). This is, of course, an effect of the ice of the glacier and the icebergs. From 200 to 600 metres the

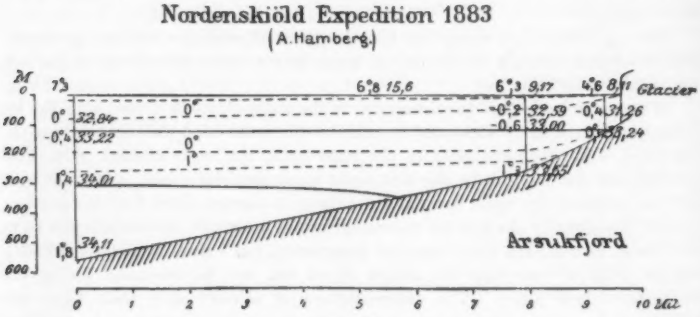

FIG. 16.

temperature is uniformly +1°·4 C. and +1°·3 C., at the bottom +1°·8 C. The state of the Arsuk fjord is a striking example of the hydrographic conditions I have tried to realize in the experiment just described. There has evidently taken place an inflow of warm and salt Atlantic water from the under-current of Davis strait over the coast bank into the Arsuk fjord at some previous

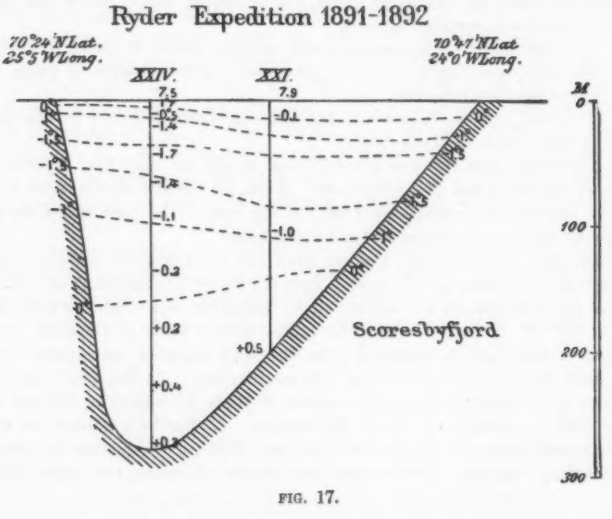

FIG. 17.

occasion. That the inflow of such water is intermittent and not continual is proved by Hamberg's deep soundings on the coast bank outside the fjord, where he nowhere found water of higher salinity than 33·75 per cent., while the salinity of the bottom water inside the fjord was 34·11 per cent.

In Fig. 17 is represented a transversal section of another ice-fjord, the Scoresby

fjord, on the east coast of Greenland at 70° 31′ N. lat., 25° long. W., made by C. Ryder * in 1891.

Scoresby fjord is an ice-fjord of the same hydrographical type as the Arsuk fjord. It receives its warm bottom water intermittently by an inflow from the warm under-current which Ryder discovered outside the coast bank of Greenland. The highest temperature in the interior of the fjord (+0°·5 C. at 45 metres' depth) is not much inferior to the maximum of temperature (+0°·6 C.) in Ryder's station xxvii. at 300 metres' depth outside the coast bank. But the entrance to the fjord is deeper, the debit of ice from the glaciers greater (Ryder mentions that great icebergs, 60 to 100 feet in height, emerge from the different branches of the fjord), and the supply of warm water more scanty than in the fjords at the western coast of Greenland. Consequently, we find the limit between the cold upper layer and the warmer bottom water beneath the level of the icebergs as deep as 150 metres from the surface.

From the deep soundings of Dr. F. Åkerblom, hydrographer to the Nathorst expedition to Greenland in 1901, we can form an idea of the hydrographic state of the Franz-Josef fjord on Greenland's east coast at 73° N. Lat.

FRANZ JOSEPH FJORD.

Station xiv.,† August 13, 1901. Lat. 73° 9′ N., long. 27° 15′ W.

Depth.	Temperature.	Salinity.	c.c. N_2 in 1 L.	c.c. O_2 in 1 L.	$\frac{100\ O_2}{N_2 + O_2}$
		‰	c.c.	c.c.	per cent.
0	+ 4°·28 C.	15·35	16·34	7·78	32·14
10	+ 0°·45	31·08	—	—	—
28	− 1°·37	32·52	—	—	—
60	− 1°·50	32·97	—	—	—
100	− 1°·53	33·62	—	—	—
150	− 1°·38	34·02	—	—	—
300	− 1°·33	34·07	16·14	6·93	30·05
450	− 0°·80	34·70	15·56	6·42	29·21
634	− 0°·45	—	—	—	—

The Franz Josef and King Oscar fjords abound in glaciers and magnificent icebergs. The melting of such ice-masses has nearly exhausted the amount of free heat stored up in the water ‡ unto a depth of more than 300 metres. Under that niveau there is a layer of water of higher salinity (34·7 per cent.) and higher temperature, which increases somewhat towards the bottom. This is a remainder of a former inflow of warmer water over the coast bank (the depth of which is unknown), which at the time of the deep sounding was shut off from communication with the ocean, as we may infer from the reduced amount of oxygen of this water, which at full saturation ought to have held 34·42 per cent., but holds not more than 29·21 per cent.

Wherefrom comes the inflow of warm water which at intervals enters into the deep of the Franz Joseph fjord? According to my opinion, it is furnished by an under-current of Atlantic water, which at about 72° lat. branches off from the main body of such water in the Norwegian sea, and north of Jan Mayen flows in a

* "Meddelelser om Grönland," xvii., plate xi., 1895.

† 'Recherches Oceanographiques.' Par F. Åkerblom. Upsala Univ. Arsskrift, 1903, p. 28.

‡ The freezing-point of 34 per cent. is −1°·85 C.

north-westerly direction towards the coast of Greenland. This theory has been much contested by Nansen* and Åkerblom,† who uphold the hypothesis first advanced by Ryder,‡ viz. that the warm water which is found at the eastern coast bank of Greenland under the polar current derives from the warm under-current west of Spitzbergen, which between that island and Greenland divides in two branches, whereof one bends to the west and south, following the coast of Greenland.

It is evident that if an under-current of Atlantic water traverses a region of ice-cold polar water it can be traced by the maximum of temperature and salinity which appears in every deep sounding. The following results of such deep soundings in the sea between Jan Mayen and the eastern coast of Greenland seems to me to bear evidence concerning the existence of the warm under-current in question :—

	Östergren. July 26, 1900. 72° 10′ lat. N., 10° 57′ long. W.		Åkerblom. July 1, 1899. 74° 38′ lat. N., 15° 3′ long. W.	
Depth.	Temperature.	Salinity.	Temperature.	Salinity.
		per cent.		per cent.
0 M.	−0°·48 C.	31·12	−0°·95 C.	32·54
10–12 M.	−0°·05	31·00	−0°·65	32·81
20–25 M.	−1°·20	33·93	−1°·36	33·48
50 M.	−1°·43	34·52	−1°·53	34·27
100 M.	−0°·23	34·88	−1°·48	34·63
150 M.	—	—	−1°·00	34·70
200 M.	+0°·80	35·06	+0°·71	34·97
277–300 M.	+0°·55	35·05	+0°·70	34·99
500 M.	+0°·52	35·05	(Bottom, coast bank of Green-land.)	
700 M.	−0°·59	35·03		
(No bottom at 2000 metres.)				

Dr. Oestergren's deep sounding was made north-west of Jan Mayen, only 160 nautical miles from the first of Dr. Akerblom's soundings on the coast bank. It seems to me more natural to admit the probability of a direct connection between the warm under-current north-west of Jan Mayen and the warm water on Greenland's coast bank which was found *at the same depth*, 200 metres, than to accept the conjecture of Ryder—Nansen,§ that this warm under-current has made the long circuit over Spitzbergen, the hypothetical ridge, and the coast of Greenland.

In Fig. 18 is represented a transversal section of the polar current between the 74° and 75° of latitude made by Dr. Åkerblom in 1900. Under this section is a diagram construed by Mr. Sandström, showing the number of c.g.s. solenoids which represent the accelerating forces arising from the differences of density in the water. We infer from the diagram that these forces tend to spread the ice and

* F. Nansen, 'The Oceanography of the North Polar Basin,' Norwegian Polar Expedition, No. 9, p. 413.

† F. Åkerblom, 'Recherche Oceanographique,' *l.c.*, pp. 78–80.

‡ 'Meddelelser om Grönland,' *l.c.*, p. 204.

§ The observations cited in favour of this hypothesis by Nansen (p. 413 of his Memoir) bear out quite a contrary result. Oestergren, in his deep sounding at 77° lats. N., 0°·55 long. W., has hit the western part of the under-current which enters the polar basin. Amundsen's deep soundings show that there is a region between Greenland and about 4° long. W. where there is no warm under-current under the ice. This region is, as will be shown afterwards, occupied by the outflowing waters of the polar basin.

surface water of the polar current eastwards over the Norwegian sea, and to carry the warmer water below towards the coast bank of Greenland. The greatest number of solenoids is found under the ice 50 to 100 metres in depth.

Mr. Åkerblom calculates the acceleration at 250 metres to be 0·0003 cm.-sec. between st. vi. and vii., and 0·00097 between st. vii. and ix. He comes to the

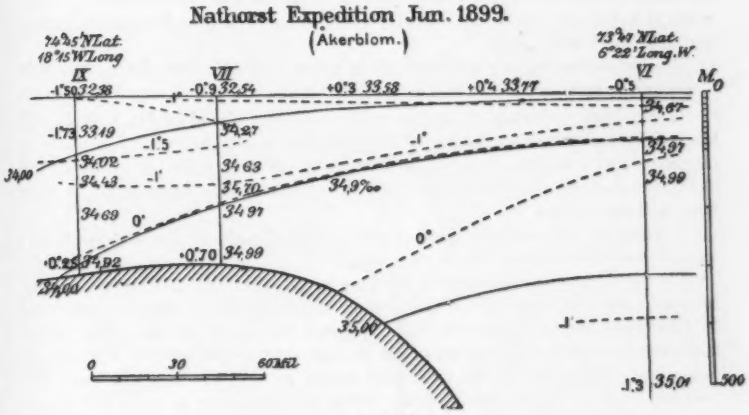

FIG. 18.

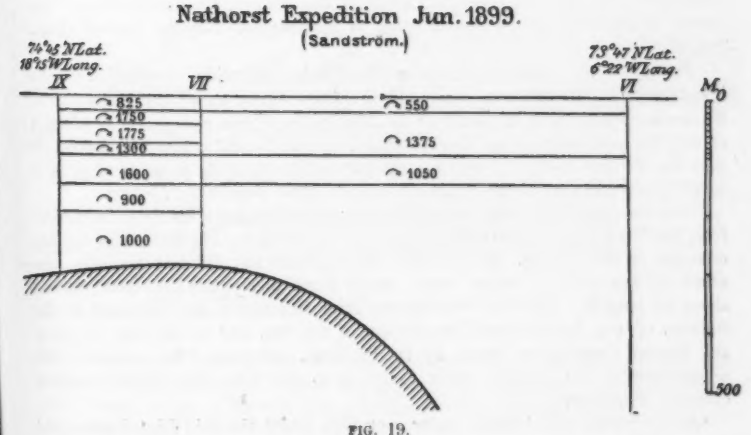

FIG. 19.

result that this force is counterbalanced by the increase of level and pressure arising from the influence of the Earth's rotation upon the south-going polar current.

In every calculus of this kind it must be remembered that, so long as we cannot take the influence of the friction of the bottom water into account, we must leave the question of the actual movement of the water open,

until we, by direct measurements, can ascertain if the warm water upon Greenland's coast bank follows with the polar current, or adheres to the bottom and is carried northwards in the opposite direction to the surface current as a "reaction current" of the same kind that Ekman discovered in the estuary of Göta Elf.

In neither case can I believe that this warm water has made the circuit over Spitzbergen, etc.; and my chief reason is, that between north-eastern Greenland and Spitzbergen there is a region where—as will be shown later—there exists no warm water at any depth, the region, namely, where the outflow from the western part of the polar basin takes place.

Further proofs of the existence of a warm under-current flowing towards Greenland in these latitudes I find in—

1. The high percentage of oxygen = 32·94 per cent. found by Dr. Åkerblom in the water samples from the bottom of the Greenland coast bank at 277 metres. If this water had belonged to an under-current which had made the grand circuit along Spitzbergen, etc., the oxygen held in solution by the water ought to have been far more reduced.

2. The high percentage of lime in the bottom deposits of the deep sea north-west of Jan Mayen (see the chart on p. 293).

The most probable explanation I can give is, that the outflow of the cold waters from the polar basin takes place chiefly along the north-eastern coast of Greenland. In this region the temperature is $-1°$ or below $-1°$ C. in all depths. This region is marked by a great tongue of ice in the ice-charts. On either side of this area we find great indentations in the ice-charts known as the "north bight" and the "whalers' bight" from Scoresby's time. From the great body of Atlantic water in the centre of the Norwegian sea, two branches in the shape of warm under-currents on each side of the Arctic area (currents of compensation) are detached, one towards the east coast of Greenland north of Jan Mayen, the other towards the interior of the polar basin along the coast of Spitsbergen. See the current chart, Fig. 20.

Thanks to the assiduous efforts of the Russian Scientific Commission for the investigation of the Murman coast and the Barentz sea, under the leadership of Knipowitsch and later of Breitfuss in Alexandrowsk, the hydrographic features of that sea now begin to be clearly defined. It can be said without exaggeration that the current system of this distant part of the Atlantic ocean is at present as well known as that of the North sea—and in some respects even better.

Over the submarine bank between Norway and Spitsbergen the Atlantic current from the Norwegian sea enters the Barentz sea, following the direction of the deepest channels of the bottom. Knipowitsch distinguishes five different branches, one north and four south of Beeren island, which begin to separate from each other at about 30° long. E. The last observations from this region are published in the Bulletin of the International Exploration of the Sea, and in the last report of the Russian Commission edited by Dr. Breitfuss. In June, 1902, he found the temperature of the Atlantic water to be up to $+3°{\cdot}6$ C.; the salinity nowhere exceeded 35 per cent.

At the surface this Atlantic water soon dips under the cold diluted water and the ice of the polar current which traverses the Barentz sea from north-east to the west. At the bottom it encounters another kind of arctic water of higher salinity than its own, 35·01 to 35·07 per cent., and of extremely low temperature, $-1°{\cdot}6$ or $1°{\cdot}7$ C.

The origin of this cold water has been a great puzzle to hydrographers. Knipowitsch was the first who discovered a layer of cold and salt water at 150 to 200 metres' depth south-west of Novaya Zemlya. Nansen declared this water to belong

to an under-current from the Kara sea through the Kara strait, which he denominated "the Lütke current." He supposes it to run northwards, following the western coast bank of Novaya Zemlya.

The recent Russian deep soundings published by Dr. Breitfuss leave no doubt about the origin of this water. In 1902 the Russian expeditions with the Andrej

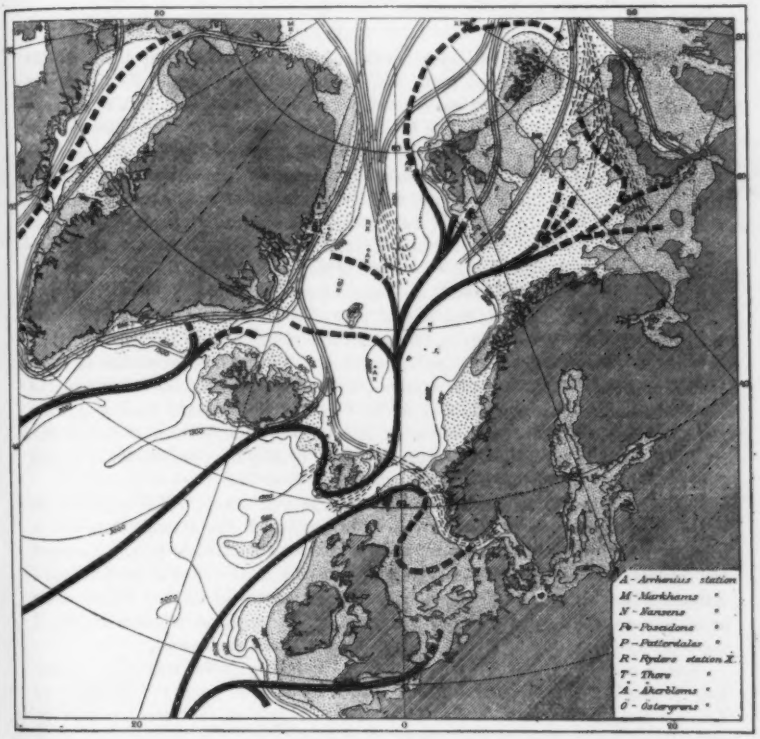

FIG. 20.—CURRENT CHART (FOR EXPLANATIONS SEE P. 289).

Perwosvanny and the Pachtussov found the characteristic high salinity and low temperature in the bottom water not only near Novaya Zemlya, but in the whole deep eastern trough of Barentz sea, according to the following extract from their deep soundings*:—

* To these examples from 1902 we can add a deep sounding made by A. Wollebœk on board the *Heimdal* in 1900, in 71° 48′ lat. and 49° 38′ long. E., who found in 120 metres a salinity of 35·20 per cent., and a temperature of −1°·8 C. If the salinity is reduced to the common standard now in use, the result will be in accordance with the Russian.

Lat. N.	Long. E.	Depth (bottom).	Temperature.	Salinity.
		metres.		per cent.
73° 14′	50° 18′	260	− 1°·46 C.	35·01
74° 29′	54° 28′	150	− 1°·70	35·07
75° 35′	56° 16′	150	− 1°·70	35·05
75° 34′	45° 28′	310	− 1°·25	35·07
75° 27′	43° 45′	310	− 1°·38	35·05

This cold and salt bottom layer is evidently an updrift from the depths of the polar sea, which enters from north and north-east both into the Kara and the Barentz sea. In the Barentz sea it principally follows the coast bank of Novaya Zemlya, and therefore spreads over the deepest part of the bottom to the west in the same manner as the Atlantic water entering from the opposite side spreads eastwards. From the Kara sea a stream of cold water is known to enter into the Barentz sea through the Kara strait, which *may* consist of such Arctic deep water ("Lütke current"). In this cold water a very characteristic fauna, chiefly consisting of *Yoldia arctica*, which attains unusually great dimensions, lives. Knipowitsch* made this important discovery south of Novaya Zemlya, at 176 metres' depth, in the summer of 1901. Formerly he had discovered a similar Yoldia fauna north of the Petschora bay and in the deepest part of the White sea. Such cold areas with an exclusively Arctic bottom fauna indicate an inflow from the polar basin.†

On the other hand, the Atlantic water will favour the existence of more southerly species where it reigns supreme, while those parts of the bottom of the Barentz sea where the Atlantic and Arctic deep waters meet and intermingle are characterized by a "boreal" fauna. The interesting distribution of boreal and Arctic food-fishes in the Barentz sea, described by the Russian biologists, is also entirely ruled by the hydrographic situation here described.

There is, however, one circumstance, hitherto overlooked, which ought to be taken into account in discussing the hydrography of the Barentz sea. It is evident that there must exist somewhere a considerable outflow from this sea of the waters arising from the intermixture of the Arctic and Atlantic water. Attention has hitherto only been directed to the outflow of diluted Arctic water at the surface which takes place on both sides of Beeren island, where a branch of the polar ice-current sends forth a tongue of water to the south-west.

But it seems probable that there must exist another outlet from the Barentz sea, for the mixed waters of higher salinity which arise from the mingling of Atlantic and Arctic water in the deep eastern region of that sea. It will be noticed that an outflow of such water, if it exists (which at present is a mere suggestion), must first take the shape of an under-current, and biologically be characterized by such species as are known as "boreal" animals and plants. I remember that Dr. Hjort once called my attention to the possibility of the existence of a south-going under-current at the Norwegian coast. Such a current can scarcely be identified otherwise than by direct current measurements at all depths along the Norwegian coast bank, the hydrography of which still presents more than one intricate problem to solve. The interest attached to this special question is chiefly of biological nature. In the Scandinavian fjords and in the Baltic there exist several "Arctic" species of animals which are regarded by zoologists, after the example of S. Lovén, as *relicts* from the glacial period.

* "Zur Kentniss der Geologischen Klimate," *Journ. Imp. Russ. Mineralogical Soc.*, Bd. & L., xi. p. 287.

† Well to observe, not a *continual* inflow.

Knipowitsch has declared the Yoldia fauna of the deep part of the White sea to be "relict."* The deep-water prawn, *Pandalus borealis*, which a few years ago was known to occur only in the interior secluded basins of some of our deepest fjords, the Drammen-fjord in Norway or the Gullmar-fjord in Sweden, was long considered to be such a relict form. Now, by the researches of Hjort, Wollebæk, and others, it has been proved that this species, which abounds in the Barentz sea, is an inhabitant of almost every deep fjord of the Scandinavian coast from Bohuslän up to Tromsö. The "relict" hypothesis can scarcely be upheld longer with regard to this species, and modern hydrography must look upon many of the doctrines of the relict theory with distrust, considering that another and more probable explanation may be expected from a closer study of oceanic circulation.

The greatest conquest of marine geography of later years is Nansen's discovery of the existence of a deep oceanic basin in the north polar region of the Eurasian continent. In spite of an insufficient equipment and adversities with the sounding-gear, etc., which were, however, remedied with admirable pluck, the *Fram* brought home from her celebrated drift across the north polar sea a large number of observations, which enable us to form an idea of the oceanic circulation of that sea, which Nansen describes as a large fjord or a 3000 to 4000 metres deep trough separated from the Norwegian sea by a shallow submarine ridge extending between the northern parts of Spitzbergen and Greenland. He supposes that this bank is lower (about 800 to 900 metres) in its eastern part, and higher (up to about 280 metres) near the Greenland coast. The Polar sea thus should be separated from the Norwegian sea by a submarine bank, in the same way as the Norwegian sea is separated from the North Atlantic by the Færoe-Iceland and Wyville Thomson banks. Nansen bases this hypothesis upon the result of his determinations of the temperature and the salinity of the deep water of the polar basin, which were both found higher than in the Norwegian sea at corresponding depths.

The question is of such importance that it becomes necessary to discuss the validity of Nansen's arguments. For such purpose we must first refer the salinities determined by Nansen to the modern standard now in use (Knudsen's tables). In Nansen's Memoir † the standard of salinity is 0·15 or 0·16 per cent. higher,‡ according to Nansen's own estimate. After this reduction the bottom water should have the following salinity and temperature:—

In the Norwegian sea = 34·94 per cent.
„ polar basin = 35·14 „

Regarding the polar basin, we have, of course, no direct determinations to compare with Nansen's, but we have sufficient data from which we *a fortiori* can form an idea about the maximal value which in all probability can be ascribed to the salinity of the deep water of that sea.

The salinity of the polar sea is maintained by the under-current of Atlantic water which passes northwards along the west coast of Spitzbergen. G. Ekman and I used the opportunity of André's first expedition to Spitzbergen with the *Virgo* in 1896 to arrange a thorough investigation of this warm current, the most northerly outlayer of the so-called "Gulf Stream." We chartered the ship for some days for a trip westward from the balloon station. Prof. S. Arrhenius, who

* Knipowitsch, 'Zur Kenntniss d. Geologischen Geschichte der Fauna des Weissen und des Murman-Meeres.' Petersburg, 1900, p. 30.

† 'The Oceanography of the North Polar Basin,' Preface, p. v.

‡ Nansen, on pp. 406 and 331, calculates the salinity of the bottom water of the polar sea from hydrometric determinations, etc., to be 35·29 per cent., and that of the Norwegian sea, if calculated in the same manner, to be 35·08 or 35·09 per cent.

accompanied André, kindly overtook the leadership, and made six serial deep soundings.* At the fourth of these deep-sounding stations, at 79° N. lat. and 4° 45′ E. long., in 400 metres' depth, Arrhenius hit the core of the warm undercurrent with a temperature of +2°·46 C. and a salinity of 35·29 per cent. As there has never been found water of higher salinity at any depth, either by A. Hamberg in 1898 (maximal salinity = 35·19 per cent.), or by Oestergren in 1900, at these latitudes, we can regard 35·29 per cent. as the upper possible limit of salinity in the waters of the polar basin.

On the other hand, we must infer from what has been said in the preceding concerning the cold and salt water found in the north-eastern parts of the Barentz sea, which I consider to be an updrift from the polar basin, that the under limit of maximal salinity of the waters of that basin cannot be put lower than that of the Lütke current, viz. 35·07 per cent. Having thus defined the limits of maximal salinity which after all probability can exist in the polar sea, it remains to see in how far these conclusions are corroborated by the actual observations of the *Fram* expedition. Before the *Fram* left the polar sea, the hydrographer in charge, Dr. Blessing, at Nansen's request, took a series of water-samples by means of an ingeniously devised water-bottle, the construction of which seems to exclude the possibility of errors from untightness of the instrument.† These water-samples are the more valuable, as they are the only authentic material for analytic determinations of salinity which was brought home from the polar sea with the *Fram*. The numerous other salinities given in Nansen's tables are computed from determinations made on board with hydrometers or with an electric method (Kohlrausch's "telephone method") recommended by H. Tornoe, which proved unsatisfactory, and was abandoned already in 1894.

Dr. Blessing's water-samples were carefully analyzed after the return. From the chlorine analyses and specific-gravity determinations on p. 214 of Nansen's 'Memoir,' I have calculated the salinities by means of Knudsen's tables. Dr. Knudsen has obliged me by controlling one of the numbers, viz. the salinity of the water from 850 metres' depth.

Fram.

November 30 and December 2, 1895.
85° 28′ 6″ N. lat., 58° 44′ W. long.

Depth.	Temperature.	Chlorine.	Salinity.
0 metres	−1°·8 C.	—	—
150 „	−1°·4	19·040 per cent.	34·40 per cent.
200 „	+0°·09	19·234 „	34·75 „
250 „	+0°·54	19·312 „	34·88 „
250 „	—	—	34·88 ‡ „
450 „	+0°·69	—	35·10 ‡ „
550 „	+0°·51	—	—
800 „	+0°·12	19·393 „	35·03 „
850 „	−0°·03	19·385 „	35·02 „
900 „	−0°·06	—	35·00 „
1900 „	−0°·71	—	—

* *Bihang K. Vetenskaps Aks. Handl.*, Bd. 23, II. No. 4, pp. 31–33.

† See the description on p. 142 of Nansen's Memoir.

‡ The salinities are calculated from the chlorine analyses in Nansen's table, reduction being made for the bromide according to the principles of Knudsen. Where the per mille of chlorine was not determined, the salinity has been calculated from the specific weights as determined by Tornoe and Heidenreich at 17°·5 C.

We infer from this that the Atlantic under-current 360 miles north of Arrhenius' station iv. (where the Atlantic water was at least 800 metres thick, with a maximum of salinity of 35·29 per cent.) was reduced to 600 metres with a maximal salinity of only 35·10 per cent.

We further infer that there is a very marked decrease of salinity with the depth from the maximum at 450 metres downwards, so far as reliable observations go, or to 900 metres. Thus the hydrographic conditions with regard to the salinity of the water of the polar basin are of the same type as those which we have found to exist in the adjacent parts of the Norwegian sea. This observation will probably also hold with regard to the temperature. The temperature of the deep water of the Norwegian sea Nansen assumes to be $-1°{\cdot}4$ C. This assumption, which rests upon Mohn's deep soundings in 1878, who found still lower values $-1°{\cdot}50$ and $-1°{\cdot}60$ C., etc., is uncertain * on account of the instruments used.

The same observation holds with regard to Nansen's temperature determinations with the Negretti-Zambra instruments, No. 75,680, 75,682, and 75,684. This conviction has forced itself upon me in studying Nansen's scrupulously conscientious report of his efforts to find the true correction of these instruments on pp. 40–58 and 237–242 of his Memoir.

Take, for example, the temperature series of the sounding at 85° 28′ N. lat. and 58° 44′ W. Here the Negretti-Zambra instrument No. 75,680 was used at 1900 metres' depth. Dr. Blessing's † reading was $t° = -0°{\cdot}65$ C.

The instrument had been tested before the departure, and the zero correction,‡ found to be $0°{\cdot}07$ C. Two months after his deep sounding at 85° lat. N. Dr. Blessing determined the zero correction § to be $-0°{\cdot}40$ C. Nansen, however, from certain reasons, reduces this correction to $-0°{\cdot}12$ C. ‖

After the return the instrument was again tested, with the result that the correction ¶ was *nil*. Nansen, in his redaction of the temperature tables, has used a "probable correction" ** of $-0°{\cdot}06$ for all temperatures determined with the Negretti-Zambra, No. 75,680, in the years 1895 and 1896.

After all, there seems to me to be still an uncertainty regarding the temperature at 1900 metres in the most northerly station: whether it is $-1°{\cdot}05$ C., or $-0°{\cdot}77$ C., or $-0°{\cdot}71$ C., or $-0°{\cdot}65$ C.

If we compare the "corrected" values of deep-sea temperatures on pp. 108–132 of Nansen's Memoir, we find variations in the temperatures below 1500 metres from $-0°{\cdot}65$ C. to $-1°{\cdot}24$ C.

Under the impression of Nansen's preliminary communications regarding the warm and salt "Gulf Stream water," which according to his observations should fill the depth of the polar basin, which could not well be explained without the assumption of a comparatively shallow suboceanic ridge between Spitzbergen and Greenland, and further regarding the great influence of the effluvies from the Siberian rivers upon the formation of the upper water-strata of that basin, I tried to explain these singular conditions by the hypothesis that the ice of the polar

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* We know with certainty only that the bottom temperature is somewhat below $-1°{\cdot}2$ C.

† Nansen's Memoir, p. 131.

‡ Ibid., p. 58.

§ Ibid. I am of the opinion that this correction ought to have been applied according to the usual rules for scientific observation.

‖ Ibid., p. 238.

¶ Ibid., p. 42. Prof. Mohn characterizes the instrument as "excellent." It is this remark of Mohn which has induced me to choose this example for my discussion.

** Ibid., pp. 58 and 238.

basin was in large measure protected from the attack of the underlying warm water by the fresh water wherein it floats.*

After a careful study of the tables of observations in Nansen's Memoir, I find that the hydrographic state of the polar basin below 800 to 900 metres must be considered as a matter of uncertainty, and that Nansen's idea that this basin is a secluded fjord separated by a shallow † ridge from the Norwegian sea and filled with water of exceptionally high salinity and temperature is not borne out by the existing observations. If the hypothetical ridge exists, it is even so possible that the temperature and salinity are lower than in the adjacent part of the Norwegian sea as that they are higher.

If we limit the discussion to the upper water-layers, the thermic conditions of which are admirably studied by Nansen and his followers, we find the usual warm under-current of Arctic seas well developed from about 200 metres. Both above and below this Atlantic under-current there is colder water of less salinity. The upper cold-water layer shows a temperature minimum at about 60 to 80 metres of $-1°{\cdot}90$ C., which is the temperature of equilibrium of ice and Atlantic water of 35 per cent. salinity. Below the warm under-current the temperature sinks under zero, and the salinity decreases slowly—the usual effect of ice-melting upon the water which gives up its heat to the ice.

After its entrance into the polar basin it is deflected to the east by the Earth's rotation, and follows the shelf of the continental plateau.‡ According to an interesting communication, just published by Knipowitsch,§ there is a bight in this continental plateau east of Franz Joseph's land, at about 65° long. E., discovered by Makaroff during his expeditions with the *Yermak*. There, in 450 metres' depth, Makaroff, by the relatively high temperature, recognized the Atlantic under-current of the polar sea first discovered by Nansen.

Nansen has shown that this under-current conserves a temperature of $+0°{\cdot}5$ C. so far as north of the Siberian islands. It shows a marked tendency to thin out towards the north, and we can easily conceive that the Atlantic water will vanish altogether as an intermediary layer somewhere in the eastern, northern, or western parts of the polar basin.

Nobody has ever sounded these remote parts of the ocean, the regions of the "palæocrystic ice."‖ Nevertheless, we can form an idea of the hydrographic conditions there from the deep soundings of Ryder and of R. Amundsen in the ice-filled area between 73° and 75° lat. N. and 1° to 10° long. W., where the whole water-stratum under the ice to 2000 metres was found to possess a temperature below $-1°$ C.

We have here the outlet from the polar basin. The channel between Spitzbergen and Greenland contains in its eastern part the inflowing under-current of Atlantic water, in its western part the outflow from the polar basin. Before the warm water has completed its circuit around the polar basin, it thins out in the same measure its store of heat is exhausted by the ice-melting process, and the products of that process, viz. the Arctic surface water and the Arctic deep water, unite and continue their course through the western parts of the polar sea until

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* See O. Pettersson, *Ymer*, 1900, p. 188.

† Nansen's Memoir, *l.c.*

‡ See Nansen's description, *l.c.*, p. 334.

§ Knipowitsch, "Ueber die Hydrologischen Verhältnisse des Nordostlichen Theils des Europaischen Eismereeres," *Revue de Peche et de Pisciculture*, Nos. 2, 3, 1903.

‖ North of Grant's land, in 83° 20′ N. lat. and 63° 5′ long. W., Markham found from the surface to 55 metres a temperature of $-1°{\cdot}9$ C., and from 55 metres to the bottom (at 132 metres) $-1°{\cdot}8$ C.

they escape along the western side of the channel between Spitzbergen and Greenland. Amundsen's and Ryder's deep soundings are representative of the state of the western part of the polar basin; Mohn's, Arrhenius', Oestergrens' soundings represent the conditions of the eastern part of that basin traversed by the *Fram*.

Ryder, sta. x.,* July 11, 1891. 75° 37′ lat. N., 6° 40′ long. W.		Oestergren, sta. i.,† July 8, 1900. 77° 11′ lat. N., 0° 55 long. W.			Arrhenius, sta. iv.,‡ Aug. 21, 1896. 79° lat. N., 4° 45′ long. E.		
0 m.,	−0°·1 C.	0 m.,	+1°·40 C.,	33·42 per cent.	0 m.,	+4°·88 C.,	34·89 per cent.
20	−0°·9	20	+0°·45	33·95 „	20	+4°·92	34·89 „
60	−1°·4	50	−0°·03	34·88 „	40	+4°·25	34·89 „
100	−1°·0	100	+1°·04	35·06 „	60	+2°·57	35·03 „
200	−0°·7	200	+1°·02	35·08 „	100	+2°·48	35·10 „
400	−0°·9	300	+0°·33	35·05 „	200	+2°·63	35·15 „
600	−0°·9	500	−0°·32	35·03 „	400	+2°·46	35·29 „
1200	−1°·2	1000	−0°·87	35·03 „	850	—	35·10 „
2000	−1°·3	2000	−1°·05	35·03 „	(No bottom)		
(No bottom)		3100	−1°·23	35·03 „			
		(No bottom)					

The upper part of the cold water and ice, on leaving the polar basin, forms the polar current along Greenland, the deeper layers of which, according to Nansen's diagram § of Amundsen's deep soundings seem to have a temperature near −1°·4 C. and a salinity about 35 per cent., sink to the bottom of the Norwegian sea in the same way as the Arctic deep water, which is formed by the attack of the Atlantic under-current upon the ice between Iceland and Jan Mayen.

On the chart on p. 313, which is drawn in order to orientate the reader with regard to the sections and stations referred to in the text, I have drawn the isobaths of 200, 600 metres, etc., after Mohn's, Nansen's, and Knipowitsch's charts, and after the deep soundings of the Nathorst expedition communicated to me by Mr. A. Hamberg. I have also represented schematically the system of currents and under-currents of Atlantic and Arctic water after the principles of the ice-melting theory.

Nansen entertains another opinion of these matters.‖ According to him, the waters of the polar basin do not play any significant direct part in the formation of the bottom water of the Norwegian sea. He says,¶ "the origin of this water has puzzled me much, as it seemed impossible that it could originate directly from the polar basin. I considered it more probable that it might be formed by cooling on the surface somewhere in the northern regions of the Norwegian sea itself."

But the difficulty is to explain how water of so high salinity can come to the surface in the north-north-west part of this sea, which is covered with ice and water of low salinity (32 to 33 per cent.) all the year round. Nansen supposes that this surface water is removed in winter, so that the Atlantic water of 35 per cent. comes into contact with the atmosphere. He thinks that this can take place in the following way: "We have seen that by the cooling during the winter the surface layers of the Gulf Stream become heavier, and this produces

* C. Ryder and K. Rördam, 'Hydrografiske Undersögelser i Meddelelser om Grönland,' xvii. p. 256. Köbenhavn, 1895.

† *Ymer*, iii. p. 325. 1900.

‡ O. Pettersson and G. Ekman, *Bih. K. d. Vet. Ak. Handl.*, Bd. 23, ii. No. 4, p. 32.

§ Nansen's Memoir, plate xxxi. ‖ Ibid., p. 146. ¶ Ibid.

an eastward motion of the surface strata overlying the bottom water in the above region. At the same time the polar current along the Greenland coast is somewhat increased during the winter, and thus the cold bottom water at Amundsen's stations may be pressed still nearer to the surface, where it is rapidly cooled down. When it is sufficiently cooled to sink, it is replaced from the sides by water that is in its turn cooled down, and so the process is repeated. The salinity of the surface water is also simultaneously increased by the formation of ice."

The coldest upper layer of the north polar region, which I consider to be produced by the attack of the warm water of the under-current upon the ice, is, according to Nansen, an inflow from other (unknown) parts of the sea. He says,* "It seems clear to me that this colder water (the water which has the minimum of temperature $-1°{\cdot}6$ to $-1°{\cdot}9$) must originate from other parts of the north polar basin where the water near the surface has a similar salinity." Also the cold bottom water of that sea, which I consider to be Atlantic water, which has given up its store of heat to the ice and sunk down, is, in Nansen's† opinion, an inflow from other (unknown) regions. He says, "We are obliged to assume that this colder water originates from some other part of the north polar basin where the overlying warmer water has been cooled down to this lower temperature," etc. These hypotheses need no commentary.

Lastly, I think something ought to be said about the much-debated question of the outflow from the Siberian rivers. Nordenskiöld founded his plan for the circumnavigation of Europe and Asia upon the probability that the streams of fresh water emerging from the mouths of the great Siberian rivers in summer would form an east-going coast stream of navigable water along the Siberian coast. The success which attended his attempt might, in some measure, bear evidence in favour of this conclusion, which can scarcely be erroneous, since it is necessary that river-water which leaves the deltas of the Lena, the Kolyma, and others, with a certain velocity in a northward direction must be deflected eastwards. From the hydrographic observations of the *Vega*,‡ I have shown that the salinity was higher to the west and lower to the east of every river. At Cape Tjeljuschkin I found that there was a break in this current.

Nansen § denies the existence of an east-going current along the Siberian coast, because in the observations of the *Fram* the freshest water was found north of the rivers, and he thinks that the observations of the Vega expedition will bear out the same rule, if the geographical position of every river lately determined by Baron Toll were substituted in the track-chart of the *Vega* instead of those given by Nordenskiöld's cartographers.‖

We must make a certain allowance for errors in the log of ships sailing like the *Vega* and the *Fram* in continual mist over a sea without certain landmarks. The discrepancy which Nansen finds to exist between the results of the *Vega* and the *Fram* expeditions can easily be accounted for, and is in fact very interesting. The *Fram's* track is more northerly than that of the *Vega*. The east-going current is probably confined to the vicinity of the coast. At that distance from the coast where the *Fram* sailed, the direction of the outflow from the rivers can have been altered by the general trend to the north and north-west which characterizes the surface water of the polar basin.

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* Nansen's Memoir, p. 323. † Ibid., p. 337.

‡ O. Pettersson, 'Contributions to the Hydrography of the Siberian Sea.'

§ Nansen's Memoir, p. 294.

‖ Ibid, p. 294.

North of the Siberian islands and of the continental shelf, no trace can be discovered of the river-water. At Nansen's stations ix. and xi., the salinity is about 29 per cent., and increases northwards and westwards to 31 to 33 per cent. The ice of the polar sea consequently floats in sea-water of more than 30 per cent. salinity, which increases with the depth until 170 to 250 metres, where the under-current is found. This upper water-layer Nansen denominates "the true polar water," and declares it to be formed chiefly by the admixture with the sea-water of the volumes of fresh water from the Siberian rivers.* To this definition I also agree on three conditions.

(1) That with "sea-water" is understood the water of the Atlantic under-current, and not any hypothetical inflow from some unknown region of the polar basin.

(2) That the term "true polar water" is taken in its widest sense, or "water of the polar current," since the same kind of water is formed not only in the polar basin, but everywhere in the course of the polar current where Atlantic water encounters the polar ice, from the Siberian islands to Cape Farewell and the coast of Labrador.

(3) That it is understood that the fresh water from the Siberian rivers is converted into ice by freezing before its admixture with the Atlantic water. It is necessary to admit this, because the intermingling of two water-layers of different salinity in a deep sea is an extremely slow process. On the other hand, the melting of ice in salt water is a most effective agency in establishing a homogeneous mixture by means of the powerful convectional currents which the ice-melting calls forth in the underlying water. The following experiment will show this.

Two large glass cylinders were filled with sea-water of 34·77 per cent. salinity, and placed beside each other on a table in the cellar of the laboratory. Two kilos. of ice were introduced into one of the cylinders, and two kilos. of ice-cold fresh water into the other, with due precautions in order not to stir the water. Twenty-four hours afterwards samples of water were taken at the following depths and analyzed:—

Depth in cms.	Cylinder with 2 kilos. ice.	Cylinder with 2 kilos. water.
	per cent.	per cent.
0	10·58	0·20
1	11·70	0·41
3	13·30	1·01
5	19·39	9·88
7	30·78	28·22
9	34·59	34·46
11	34·70	34·77
17	idem.	idem
27	"	"
37	"	"
47	34·70	34·77

We infer from this, that the presence of ice in sea-water occasions a most effective admixture between the fresh and salt water from the surface down to the under niveau of the ice. This explains why we always find salt water in the vicinity of sea-ice in Arctic seas. Under that niveau, the melting of the ice causes a slow decrease in the salinity of all water-layers to the bottom (from 34·77 to 34·70 per cent. in our experiment). This is an effect of the convective currents

* Nansen's Memoir, p. 315.

caused by the ice, and is in complete accordance with the results of the ice-melting experiment previously described. The intermixture between the cold fresh surface water and the salt water is limited to a very thin layer, and exerts no influence upon the deep water.

The fresh water which every summer emerges from the estuaries of the Siberian rivers is converted into icefloes by the atmospheric cold during the following winter on the shallow plateau north of the coast. So long as the icefloes remain in shallow water they are protected from the attack of the warmer water. Next summer, when they are drifted northwards, they come to float over a 2000 to 4000 metres deep sea. Tidal currents crush and fold the floes into hummocks of ice-blocks piled up against and upon each other. The undermost of these blocks reach to a depth of more than 60 to 80 metres, as we can infer from the fact that the minimum of temperature $-1°{\cdot}9$ C. was found at that depth by Nansen.*

The site of the minimum temperature in Arctic and Antarctic seas is always found somewhat above the depth to which the ice is immersed in the water.† In the Antarctic ocean, where there are icebergs drawing more than 500 metres of water, the minimum of temperature is found about that depth. In the Scoresby fjord, where Ryder observed magnificent icebergs of 30 metres' height, the minimum was found at 100 metres, in the Franz Joseph fjord from 60 to 100 metres. Between Iceland and Jan Mayen the minimum region is found at 40 metres, which indicates that the screwing of the icefloes reaches still deeper.‡ In the polar basin there are no icebergs, but hummocks, the height of which was found by Nansen to be 15 to 30 feet. The immersed part of these hummocks can be estimated to seven or eight times that of the visible part, or to 40 to 70 metres.

The ice-melting process is not ruled by the average depth § of the ice, but by the maximal depth to which the ice is immersed. The deepest parts of the icebergs, hummocks, or floes are attacked vigorously, the thin floes slowly.

The hydrographic state of the North sea, the Skagerack, and Kattegat is very complicated and variable. Both from the channel and from the region between Scotland, the Orkneys, and Shetlands Atlantic water enters into the North sea. North and east of Shetland Arctic deep water banks up in the manner described on p. 302 against the northern slope of the North sea plateau. At 62° to 63° lat. and 3° to 5° long. E., the Arctic deep water has access to the deep Norwegian channel, which it follows as an under-current into the Skagerack, where it is regularly found at intermediate depths (between 15 to 30 metres to 150 to 200 metres) over the deepest part of Skagerack. Under it we find from 200 metres to 650 metres Atlantic water, which has entered over the North sea plateau and over the western and south-western slope of the Norwegian channel. Above it we find in summer a thin layer of Baltic water (salinity up to 30 per cent.), in winter a somewhat thicker layer of Bank water (salinity 32 or 33 per cent.). The plankton of the Arctic water in the Skagerack is very characteristic. It consists of large crustaceans, many of which are known

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* Nansen's Memoir, p. 323.

† Nansen's section on plate xv. (see stations ix. and xi.) is very instructive in this respect.

‡ G. Amdrup, 'Meddelelser om Grönland,' xxvii. p. 139, estimates the height of this screwed ice to 25 to 30 feet.

§ This remark is a reply to a statement on p. 156 of Nansen's paper, 'Some Oceanographical Results of the Expedition with the *Michael Sars*, 1901.' Christiania, 1901.

from the deep water of the Norwegian* sea (400 to 500 metres), and even from the polar basin.† The most important forms are—

Thysanoœssa neglecta.	*Metridia longa.*
Parathemisto oblivia.	*Conchœsia borealis.*
Calanus finmarchicus.	*C. elegans.*
Chiridius armatus.	*C. obtusata.*
Euchœta norvegica.	*Krohnia hamata.*
Heterorhabdus norvegicus.	*Calanus hyperboreus.*

The Atlantic water from the Channel spreads over the shallow southern North sea plateau south of the Dogger bank, where it, however, becomes much diluted by admixture with the coast water and effluvies from the great continental rivers.

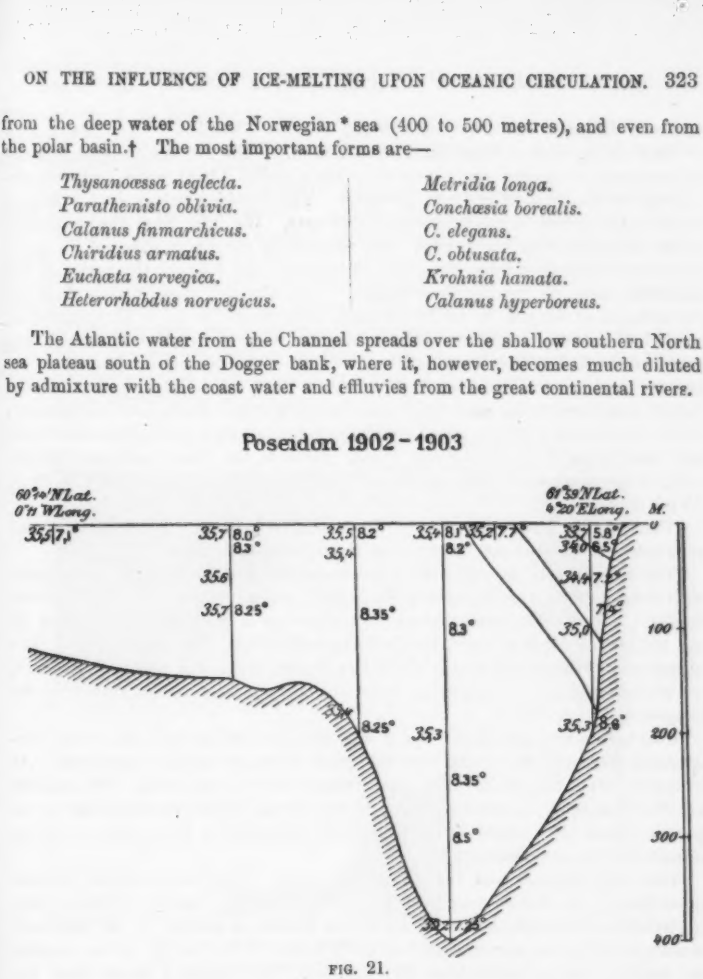

FIG. 21.

The Atlantic water from the Orkneys and Shetlands spreads, intermingled with Arctic water from the Norwegian sea, over the northern North sea plateau north of the Dogger bank, which plays the part of a kind of watershed in the circulation of the North sea, as was first distinctly proved by the excellent research in 1882-84 by the German gunboat *Drache*.‡ The Atlantic water from the southern North sea, as well as the Atlantic water from the regions north of the Dogger bank, enters the Skagerack along the coast bank of Jutland, and, on account of its greater density, fills the deep trough of the Norwegian channel and the Skagerack as already mentioned. The peculiar hydrographic conditions of the eastern North sea and Norwegian channel are shown in a section from Bergen to the Shetlands,

* 'Svenska Hydrografiska Kommissionens Skrifter,' i. 3, p. 2.

† G. O. Sars, 'The Norwegian North Polar Expedition,' V. "Crustacea." 1900.

‡ 'Ergebnisse der Untersuchungsfahrten der Kubt. Drache in der Nordsee, 1882-84.

made in January, 1902, by the German steamer *Poseidon*.* The water-layer of 33 to 34 per cent. salinity found in station iii. off the Norwegian coast between 0 metres and 70 metres' depth consists of the so-called "bank water," wherein the herring shoals are usually found in winter. The *Poseidon* arrived in the herring season, and partook in the fishery with drift-nets. We infer, from the description of Dr. Perlewitz, that the herring were exclusively caught in water of 33 to 34 per cent. a few miles from the coast. Further to the west, in the region of the Atlantic water, no herring were caught. The diagram shows clearly that the water-layers of 33 and 34 to 35 per cent. salinity and 5° to 6° C. temperature must have another origin than the salt inflow from the north-west, which was found on the little Fisher bank and in the depths of the Norwegian channel, where the temperature was found as high as up to 10°·2 C. In the plankton of the former were found forms such as *Limacina retroversa* and *Thalassiotrix longissima*, while the Atlantic water contained radiolarians, diatoms such as *Euodia cuneiformis* and other forms of more southerly origin. Between the Fisher bank and Heligoland, on the shallow southern plateau of the North sea, was found water of 34 to 35 per cent. as usual.

These waters enter through the funnel-shaped orifice of the Skagerack, and penetrate as under-currents through the Kattegat into the Baltic.

The Skagerack is the only part of the sea which has been hitherto investigated with regard to its current system by actual current measurements at different depths. The following chart represents the currents of the Skagerack between 20 and 100 metres' depth as found by the Swedish expedition † in August, 1901. The surface water everywhere, except along the Danish coast, was flowing westwards, but 20 metres under the surface we found the characteristic current system of the Skagerack well developed.

Over the deepest part Arctic water was found at stations Svii. and Sviii. oversaturated with oxygen, containing the great Copepods already mentioned. At 30 metres' depth the minimum of temperature +4°·9 C. was found. The salinity was 34·47 per cent. Isolated remnants of such Arctic water were found also in the greatest depths (200 metres) of the Kosterfjord characterized by the same plankton animals and the same salinity.

From the northern and the middle part of the North sea a mighty current entered along the Danish coast. This water contained an entirely different kind of plankton—*Tripos* plankton. North of the Skagen in station Sii. its maximum velocity at 40 metres was measured to be 59·9 cms. to the second; at the surface the velocity was not more than 28·9 cm.-sec. The inflowing waters from the North sea impinging upon the Swedish coast divided in two currents, one flowing northwards and westwards, another running southwards into the Kattegat. In the former current we measured the greatest velocity at 20 metres' depth in station Sx. = 70·7 cm.-sec. The velocity of the surface water in the same station was not more than 32·3 cm.-sec.

The under-current of water from the North sea conveyed a multitude of jellyfish, *Cyanea capillala* and *Aurelia aurita*, accompanied by small whitings of 44 to 87 mm. In the stomach of this breed we found the following plankton animals: *Temora longicornis*, *Calanus finmarchicus*, *Centropages typicus*, *Sagitta bipunctata*, which all belong to the Tripos plankton of the North sea. Breed of cod was not

* P. Perlewitz, 'Bericht über die Fahrt des *Poseidon*, December, 1902, and January, 1903;' 'Mittheil. des Deutschen Seefischerei-Vereins, Okt. 1903.'

† P. T. Cleve and O. Pettersson, 'Svenska Hydrografiska Kommissionens Skrifter,' i. *l.c.*, 3, p. 9.

present. Dr. J. G. Petersen, earlier in the same summer, had also observed the absence of young cod. Dr. Petersen concludes that the breed of cod lives outside the Skagerack during the summer.

In the southern part of the North sea another kind of water, the southern bank water, with its characteristic plankton (*Didymus* plankton), was found. With the inflow of this water, which commenced in the last days of August, began, as usual, the autumn herring-fishery in Kattegat. By the inflow of the southern bank water the under-current through the Kattegat, which had only 16·5 cm.-sec. velocity at 60 metres in station S_0, August 2, 1901, increased.

In winter and early in spring the Arctic water has its time of inflow into Skagerack, in the summer months the waters from the northern and middle North sea predominate, and in autumn comes the time of the inflow from the southern North sea of the southern bank water.

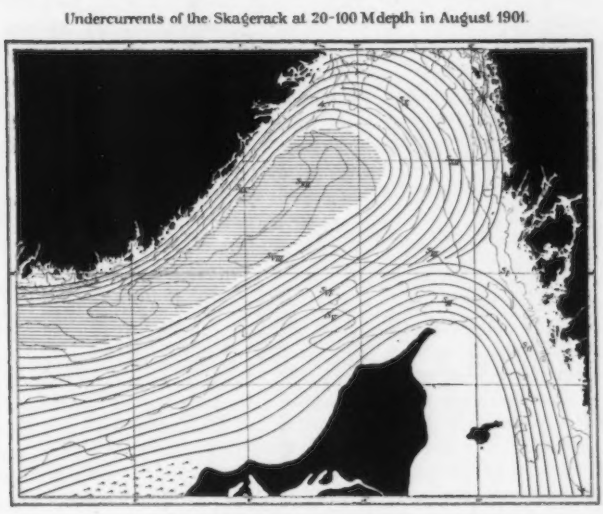
Undercurrents of the Skagerack at 20-100 M depth in August 1901.
Arctic water of 34‰ & remnants of arctic water in the fjords
34‰ water from the N. Sea with tripos plankton.
Southern bankwater with didymus plankton

FIG. 22.—CURRENT SYSTEM OF THE SKAGERACK.

This periodicity of the hydrographic conditions of the Skagerack is ruled by the great annual changes which take place in the ocean.* In autumn the flow of the Atlantic water towards the channel and the North sea and Norwegian sea increases in strength. On the following page are copied two hydrographic sections made by the hydrographer of the Nathorst expedition, Dr. F. Åkerblom, one in June, the other in September. At my proposal, Dr. Åkerblom made deep soundings at the same stations on the voyage to and from Greenland, and the commander of H.M.

* See 'Les variations annuelles de l'eau de surface de l'ocean Atlantique,' par P. T. Cleve, G. Ekman, O. Pettersson (Gothenburg, 1901); and "The Circulation of the Surface Waters of the North Atlantic Ocean," by H. N. Dickson., *Phil. Trans.*, Sec. A. vol. 196|(1901).

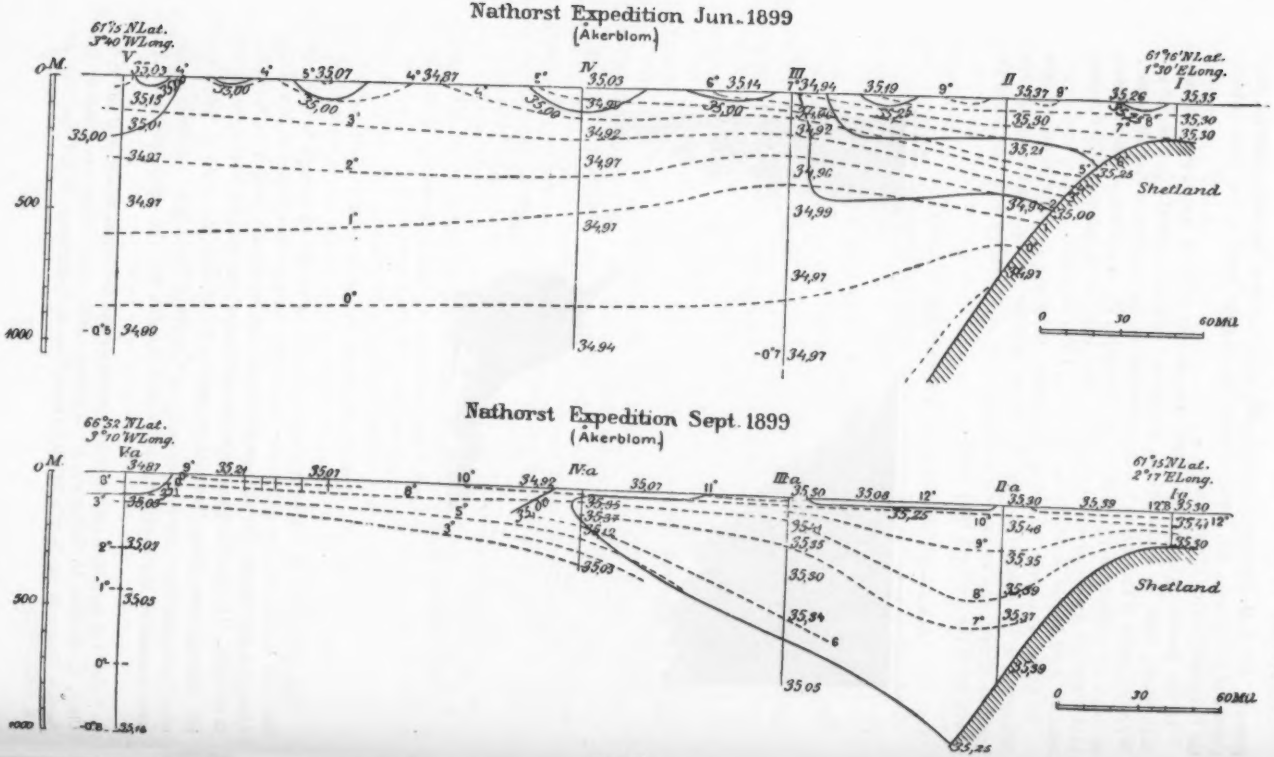
Nathorst Expedition Jun. 1899
(Akerblom)
61°7s NLat.
3°40 WLong.
V
61°16'NLat.
1°30'ELong.
I
Shetland
0 30 60MIL
Nathorst Expedition Sept. 1899
(Akerblom)
66°32 NLat.
3°10 WLong.
Va
61°15NLat.
2°17'ELong.
Ia
Shetland
0 30 60MIL

FIG. 23.

Frigate *Freja*, Mr. Sidner, completed the series by a number of deep soundings in the North sea. The track of the ship is marked out in the chart.

The accumulation of warm and salt Atlantic water in the Norwegian sea north of the Shetlands from June to September, appears very conspicuously from the isohalines of 35 and 35·25 per cent.

The alternate inflow of Atlantic and Arctic water exerts a predominating influence upon the fish-life and the migrations of food-fishes, such as the herring, the cod, the mackerel, the hake, and others in our seas. As an example of the influence of the hydrographic conditions upon the fish-life of the Baltic, the result of our trawling experiments in the Baltic east and west of Bornholm, in October, 1901, may be mentioned. In both places the trawl brought up a relatively considerable number of plaice in spawning condition. The unusual season for spawning can be explained from the fact that the under-current from the Kattegat at this time of the year brings in a larger supply of warm and salt water into the recesses of the southern parts of the Baltic. We measured a velocity of 57 cms. to the second in this (in-going) under-current at 50 metres' depth in the deep channel between Bornholm and Skåne, on October 11, 1901.

Into this layer of warm and salt water which the under-current, during the last months of the year, accumulates in the deep recesses of the Baltic, the fishes take their refuge in winter when the upper water-stratum (the "Deckschicht") of this sea is cooled down to +1° or +2° C. from the surface to 30 to 40 metres' depth. In the summer months, July to September, we have always found these deeps of the Baltic empty of edible fishes.

The periodic inflow of water through the Sund and the Belt sea is felt in the Baltic at least so far as to the region east and west of Bornholm. Regarding the circulation in the interior part of the Baltic, the under-currents of the Bothnian sea, etc., I must refer to a former paper.* The under-current of the Kattegat and Baltic has not the character of a steadily flowing bottom stream. The outgoing and ingoing water-strata assume the shape of opposite cuneiform tongues or wedges, which appear sharply defined by the trend of the isohalines in the hydrographic sections. In case of equal atmospheric pressure over the Baltic and the North sea area, each current pursues its own way, but if the barometric pressure increases over the south part of the Baltic, the under-current in the Belt or Kattegat is stopped or even forced to run in a retrograde direction by the increased hydrostatic pressure at the southern end of the Kattegat, and *vice versâ*. From measurements made on board of lightships, Cronander† has proved that in the shallow parts of the Kattegat the surface water and the bottom water, in the plurality of occasions, move in the same direction, but with different velocity northwards or southwards. The oscillatory character of the movement over a shallow bottom plateau very much contributes to the admixture of the waters. The Baltic current increases in salinity from 10 to 30 per cent. during its course from the Sund to the point of Skagen.

In the Baltic, between Rügen and Skane, the salt water of the under-current flows along the German coast bank, as will be seen from the section on the following page.

Formerly it was believed that there existed a certain difference of level between the Baltic and the Skagerack, which acted as the *vis movendi* of the Baltic current.

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* O. Pettersson, "A Review of Swedish Hydrographic Investigations," *Scottish Geographical Magazine*, 1894, pp. 624–630.

† E. W. Cronander, 'On the Laws of Movement of Sea-currents and Rivers,' (Norrköping, 1898), p. 38.

This idea must now be abandoned, since a careful levelling has proved that the water-mark at Ystad (Baltic) is 0·024, and that of Landsort (Baltic) 0·023 metre below the mean annual level of the water at Varberg (Kattegat). The seasonal and annual variations of the water-stand of the Kattegat and the Baltic also follow each other closely.* Moreover, it has been proved † by Bjerknes and Sandström that the accelerating forces which arise from the differences of density in the waters of the Baltic proper are not sufficient to account for the movements of the upper and lower water-layers in the Belts and the Kattegat. Consequently we must infer that the influence of the ocean is the paramount power which governs the circulation of the Baltic. To the same conclusion we arrive also from the following considerations. The water of the Baltic is, with regard to its chemical components, diluted ocean water. The relation of the different saline components to each other

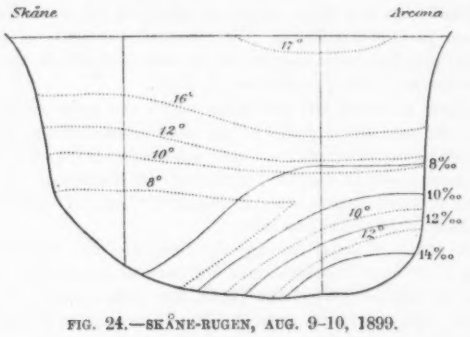

FIG. 24.—SKÅNE-RUGEN, AUG. 9–10, 1899.

is the same as in ocean water, or so nearly the same, that the salinity and density of a water-sample from the Bothnian gulf can be calculated from its amount of chlorine by the same formula as holds for the water of the Pacific, the Mediterranean, the polar basin, etc.

From the preceding it will be understood that the oceanic circulation in the tributaries of the North Atlantic has a greater intensity and larger extension than hydrographers usually are prone to admit. The periodicity of this circulation is most conspicuous in the eastern parts of the North sea and in the Skagerack and Kattegat. The hydrographic situation here is a very complicated one, but as the waters of different origin are easy to discern from each other by their chemical and physical properties, and the leading plankton forms and the correspondency between the migrations of the fishes and the hydrographic seasonal changes become obvious to every observer who takes the trouble to repeat the same observations in the same place at different seasons of the year, it seems quite natural that the Scandinavian scientists, from the experience gained in their own seas, uphold the idea that the hydrographic state of a sea is the first and paramount ruler of its fish-life, and that fishery statistics can elucidate this matter *only if combined with a thorough study of the very changeable conditions under which the higher orders of marine animals live.*

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* P. G. Rosén, "Om Hafsytans Höjdförhållande vid Sveriges Kuster 1887–1900," *Svenska Hydrografiska Kommissionens Skrifter*, I. 5, 1901.

† V. Bjerknes and J. W. Sandström, 'Ueber die Darstellung des Hydrographischen Beobachtungsmateriales durch Schnitte' (Göteborg, 1901), pp. 3 and 4.

ORDNANCE SURVEY MAPS.

The following is a list of the various Ordnance Survey Maps of the British Isles on sale to the public, together with the prices. E. Stanford, 12, 13 and 14, Long Acre, W.C., is the London agent; there are also provincial agents in most of the important towns of England, Scotland, and Ireland. In places where no agent exists, the maps can be obtained through the principal local post offices.

10 miles to 1-inch Scale.

	Price per sheet. s.	d.
1. Great Britain, engraved. Printed from a transfer from copper, with water in blue, latitude and longitude not marked. Size about 20 × 13 inches. On paper	1	0

4 miles to 1-inch Scale.

2. England and Wales, engraved in black, latitude and longitude marked, no hill shading or contours. Size 22½ × 15 inches. On paper	1	6
3. England and Wales, engraved. Printed from a transfer from copper, hills in brown, roads sienna, water blue, woods green. Size 22½ × 15 inches. On paper	1	6
4. Scotland, engraved. Printed from a transfer from copper, with water in blue, latitude and longitude marked, no hill shading or contours. Size 18 × 12 inches. On paper	1	0
5. Scotland, engraved. Printed from a transfer from copper, hills in brown, roads sienna, water blue, woods green. Size 18 × 12 inches. On paper	1	0
6. Ireland, engraved. Printed from a transfer from copper, with water in blue. Size 18 × 12 inches. On paper	1	0
7.*County and District Maps of Great Britain, cheap edition, roads in brown, latitude and longitude marked, on thin paper or folded in covers. In sheets. Unmounted . . . . . 6*d.* and	1	0
Folded in covers . . . . . 9*d.* and	1	0

2 miles to 1-inch Scale.

8.*England and Wales, photo-etched on copper. Printed from a transfer from copper, hills and contours in brown, first-class roads, burnt sienna, woods green, water blue, latitude and longitude marked. Size 18 × 12 inches. Mounted on linen and folded in cover	1	0

1-inch Scale.

9. England and Wales, outline, contours in black, latitude and longitude marked. Size 18 × 12 inches. On paper	1	0
10. Ditto, hills hachured in brown, latitude and longitude marked. Size 18 × 12 inches. On paper	1	0
11. Ditto, hills hachured in black, latitude and longitude marked. Size 18 × 12 inches. On paper	1	0
12. Ditto, hills hachured in brown, contours red, roads sienna, water blue, magnetic variation shown, latitude and longitude not marked. Size 18 × 12 inches. On linen-backed paper or mounted on linen, either flat (with a few exceptions) or folded in covers. Single sheets	1	0
Combined sheets	1	6

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* Publication in progress.

	Price per sheet. s. d.
13. Scotland, outline and contours in black, latitude and longitude marked. Size 24 × 18 inches. On paper	1 9
14. Ditto, hills hachured in brown, and black contours, latitude and longitude marked. Size 24 × 18 inches. On paper	1 6
15. Ireland, outline, not contoured, in black, latitude and longitude marked. Size 18 × 12 inches. On paper	1 0
16.*Ditto, outline, not contoured, in black, latitude and longitude marked, showing county, rural, urban, and county borough boundaries in red. Size 18 × 12 inches	1 0
17. Ditto, hills hachured in black, latitude and longitude marked. Size 18 × 12 inches. On paper	1 0
18.*Ditto, hills hachured in brown, roads sienna, water blue, woods green, latitude and longitude marked. Size 18 × 12 inches. On linen, backed paper, either flat or folded in covers	1 0
19.*Combined maps of areas round certain large towns, or other areas, such as the New Forest and Lake District, and published in various forms and sizes. These maps usually show outline and contour in black and roads in brown. In sheets, unmounted 9*d.* to Folded in cover 1*s.* to	1 6 1 6

6-Inch Scale.

20. Great Britain, water coloured blue or back lined, contours in black, latitude and longitude marked. Heliozincographed or photozincographed. Size 18 × 12 inches Engraved or photozincographed (where not published in quarter sheets). Size 36 × 24 inches	1 0 2 6
21. Ireland, engraved or heliozincographed, contours in black, latitude and longitude not marked. Size 36 × 24 inches	2 6

$\frac{1}{1250}$ Scale.

22. Houses ruled in black, water blue or back lined, latitude and longitude not marked. Size 38 × 25½ inches	3 0
23. Houses red, water blue, roads brown, latitude and longitude not marked. Unrevised editions only coloured in this form. Size 38 × 25½ inches. From 2*s.* 6*d.* to 23*s.*, according to the amount of colouring. This form is gradually being superseded by 22.	

Town Scales.

24. $\frac{1}{500}$ scale, houses stippled. Size 38 × 25½	2 6
25. Ditto, houses ruled. Size 38 × 25½	2 6
26. Ditto, houses red, water blue, roads brown. Size 38 × 25½ inches. From 2*s.* 6*d.* to 15*s.*, according to the amount of colouring. Applies to unrevised only.	
27. 5-feet scale, houses stippled. Revised. Size 36 × 24 inches	2 6

Index Maps.

28. Indexes to the sheets of the 1-inch scale maps of England and Wales, Scotland, and Ireland, scale 30 miles to an inch. Sizes about 18 × 13 inches	0 2
29.*Index to the sheets of the 6-inch scale map, parishes coloured. England and Wales. Size 18 × 12 inches Scotland. Size 24 × 18 inches	1 0 1 6
30.*Index to the sheets of the 1 : 2500 scale map, parishes coloured. England and Wales. Size 18 × 12 inches Scotland. Size 24 × 18 inches	1 0 1 6

Nos. 29 and 30 are identical with Nos. 9 and 13, but with sheet lines added, printed on thin paper, and coloured to show civil parishes.

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* Publication in progress.

Concluding Remarks.

I have tried to show that the melting of the ice in the western and northern parts of the Norwegian sea exercises an influence upon the hydrographic conditions of all other parts of that sea. This influence must be of a periodic nature, since the melting of ice is so closely connected with the seasons of the year. Our ice-melting experiments show that that part of the water which descends is far greater than that which ascends and spreads over the surface. In my study of the ice-melting phenomenon in the sea between Iceland and Jan Mayen, I have calculated that part of the Atlantic under-current which mixes with the ice-water to be one-eighteenth, while the remaining seventeen-eighteenths become cooled from contact with the ice and sink to the bottom, there to form the great bottom layer of cold water of only $-1°{\cdot}0$ to $-1°{\cdot}4$ C., which is the lowest temperature existing in any ocean on the globe.* It is, in fact, not far from the limit $-1°{\cdot}905$ C., which is the point of equilibrium between sea-water of 35 per cent. and ice. If in any year the hydrographic deep-soundings should indicate so low a temperature in the bottom-water, it would signify, either that the balance between the Atlantic water and the polar ice in the Norwegian sea was equal, or that the ice was in excess.

What this would signify with regard to the climate and meteorological conditions of Northern Europe can easily be imagined. The ice-filled area would rapidly extend from the western towards the eastern side of the Norwegian sea. Under the actual circumstances this encroachment of the polar ice-floes upon the warm-water area is checked by the inflow of Atlantic water, which must be in excess, since the bottom temperature is still at least $0°{\cdot}5$ above the temperature of equilibrium, $-1°{\cdot}9$ C.

If the supply of warm water is in excess of the ice, the cooled sea-water will mix with other water which has not been in contact with ice, and generate a bottom layer of higher temperature.

Such is the case in the Atlantic, Indian, and Pacific oceans, where the bottom temperature is above 0° (from +1° to +3° C.).

We infer from this that the hydrographic conditions of the Norwegian sea must be of a very labile character. In some years the ice predominates, as was the case in the summer of 1902, when Iceland in April was surrounded by polar icefloes, and the issuing current advanced so near to Europe that its cold waters were found in the midst of the Färoe-Shetland channel by the British International Expedition in August, and isolated blocks of polar ice were observed south of the Hebrides.

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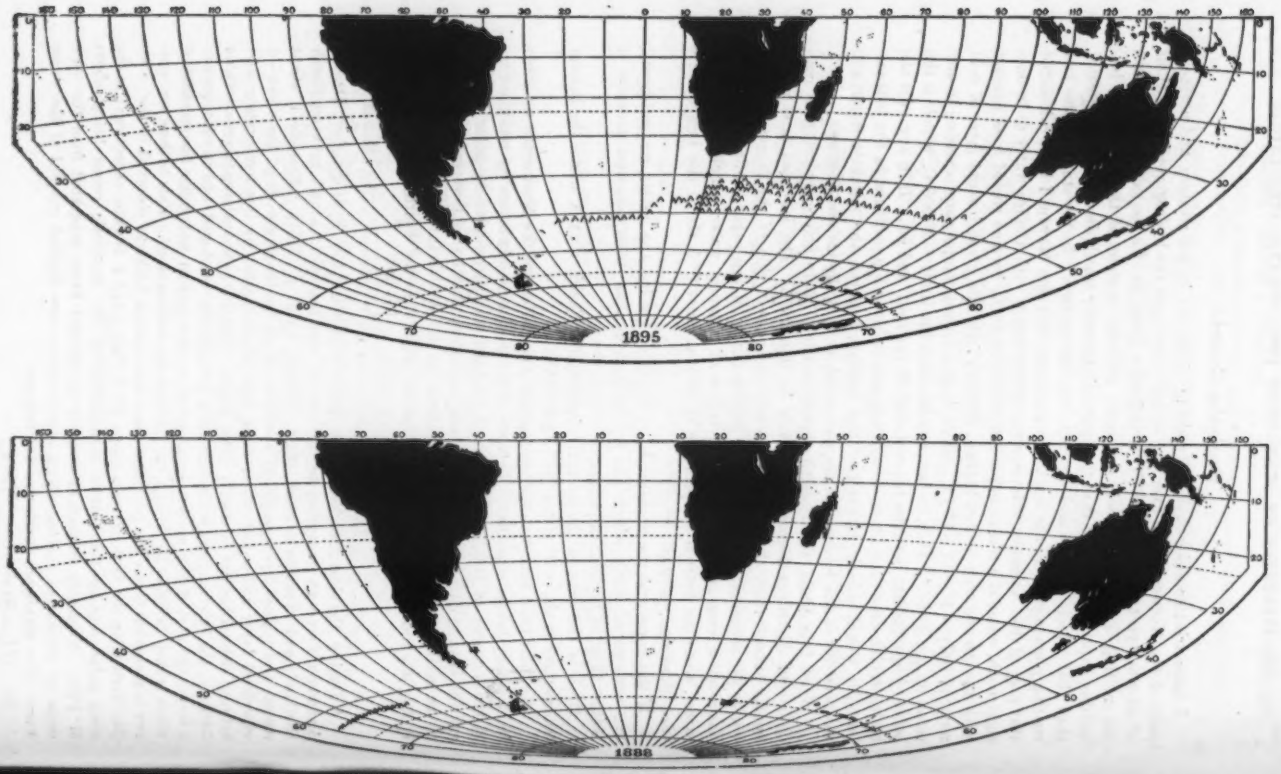
* During the last Swedish south polar expedition the hydrographer, Dr. G. Andersson, found an exception to this rule in the Bransfield sound between South Shetland and Graham's Land (this *Journal*, xxiii. p. 216): "Bransfield strait repeats the typical hydrographical condition of all ice-bearing parts of the ocean—a superficial layer and a deep-water mass, both characterized by low temperature, and between them a body of relatively warm water. But this section shows two remarkable features: the intermediate warm current is here faintly developed, and in consequence a very large part of the section is occupied by the bottom water, the temperature of which is only $29°{\cdot}66$ to 29° Fahr.), the latter at the bottom itself. This bottom temperature is somewhat below the minimum deep temperature hitherto observed in the ocean (the Norwegian sea, bottom temperature $29°{\cdot}3$ Fahr.), and it is quite exceptional in the south polar regions, the bottom temperature of the Antarctic ocean being about 31° Fahr. Evidently Bransfield strait is an isolated basin, separated from the open ocean by submarine shelves, which admit only a very limited renewal of the warm water. The maximum depth was 826 fathoms."

ICEBERGS IN THE SOUTHERN OCEAN.



There can be no doubt that the rough weather of that summer must be ascribed, for a great part, to this cause.

It is well known that all polar currents are extremely variable, not only from summer to winter, but also from one year to another. The grandest variations are found in the extent of the drift of the icebergs from the south polar continent. The influence of ice-melting is greatest in the south polar sea, because the icebergs here are greater than anywhere else. The energy set free by ice-melting is proportional to the depth of the submerged part of the ice. While 1 kilogram of ice belonging to an icefloe of the Greenland ice-current of 1 metre depth in melting produces an amount of work equal to 0·0139 kilogrammetres, another kilogram of ice from the undermost part of an iceberg which floats 500 metres deep gives birth to 7 kilogrammetres if melted in contact with one of the warm under-currents of the South Atlantic and the Indian ocean, which enter into the south polar sea following the deep channels east of Bouvet and west of the Kerguelen islands. It is a well-known fact that great "outbursts" of icebergs from the Antarctic sometimes take place, which shows that the state of equilibrium between ice and warm water is unstable also on the southern hemisphere. On the opposite page this outburst of ice from the south pole is represented by two charts, of which the material is borrowed from Mr. Russel's charts in 'Icebergs in the Southern Ocean.' Such outburst of south polar ice, whereby icebergs are drifted northwards to lower latitudes, will of course influence the state of the upper layers of the Atlantic, Indian, and Pacific oceans by reducing the surface temperature of the water. It is evident that the surface of the Indian ocean will be influenced most of all by the ice-melting in its southern part, and it remains to ascertain how far the cold water spreads northwards every year, and how far this cold water encroaches upon the warm area from which the water evaporates, which ultimately falls down as monsoon rain upon the adjacent coasts of India, Australia, etc. We must look out for the possibility that there exists a connection between the climatic variations of these countries and the outburst of ice from the south pole. It is a matter well worth noticing that the great droughts of India of later years fall in the last decennium of the former century, which was also the time of the last great outburst of ice from the Antarctic (1892–98).

The excellent meteorologists of the Indian Empire, M. Blanford and others, have long sought some device to forecast the droughts of India. At first they sought to found such forecasts upon observations of the snow cover of the Himalayan mountain ranges. Then they found it necessary to establish a grand net of observations upon the islands of the Indian ocean. If I might venture a suggestion, it would be this: to extend those observations all over the southern part of the Indian ocean, to institute regular surface observations on board of steamers, and to execute every year a number of deep soundings at certain stations from the equator to the deep channel west of Kerguelen.

The most prominent feature in the hydrography of the Indian ocean is the existence of a relatively thin superficial layer of very hot water superposed upon a large mass of cold water of Antarctic origin. By means of a large number of surface observations, combined with a small number of deep soundings executed at representative points, the extent of the warm area and the depth of the "Deckschicht" might be systematically investigated every year with the purpose of ascertaining the annual variation of its heat capacity. When the relations between the hydrographic and meteorologic phenomena are better acknowledged, the urgent necessity of substituting a systematic investigation of the sea instead of the occasional cruises of reconnoitring expeditions now in use will be understood.

With regard to the relation between hydrographical and meteorological

phenomena, I must refer to a previous paper, in which I have shown * that variations both in the extent and in the temperature of the warm-water current from the Atlantic take place from one year to another, and that even a small increase or decrease in the mean monthly temperature of the surface water of the Norwegian sea causes great variations in the air-temperature of Sweden during the winter months—January to March. The influence of the Atlantic water upon the atmospheric temperature, which is so marked in winter that we might forecast the character of a coming winter from the hydrographic condition of the Norwegian sea in December, is, however, almost obliterated in summer. The earliest phænologic phenomena of the year,† *e.g.* the growth and blooming of spring plants, and likewise the commencement of the farming work in Sweden, seem to be ruled by this influence, but not the rainfall and the temperature of the summer months, the time of the harvest, etc. The conclusion that the inflow of the Atlantic water rules our climate in the winter, but not in summer, is also borne out in the most conspicuous manner by Dr. N. Ekholm's charts ‡ of the temperature isanomalies of the Scandinavian peninsula in January and in July.

The relation between the hydrographic condition of the sea and our summer climate is far more obscure. The only thing which can be said with certainty is, that the extent of the ice-filled area of the Norwegian sea in spring exerts an influence upon the barometric pressure, the rainfall, the harvest, etc., of North-Western Europe. At least it has been found so in the extremest cases of dry and hot or cold and wet summers. It is remarkable that this influence appears to be stronger developed in Denmark, Prussia, etc., than in Sweden and Norway. The Berlin meteorologists, Dr. W. Meinhardus § and Dr. Brennecke,‖ have lately published some highly interesting papers upon this subject.

The mighty upper layer of the Baltic ("Deckschicht") absorbs a great quantity of heat during the summer, which in autumn and early in winter is given up to the atmosphere. This exerts a strong influence upon the climate of the Baltic islands, Bornholm, Gotland,¶ and others. Prof. T. Homén, leader of the international hydrographic research in Finland, has of late published successful forecasts of the climate of the coming winters based upon the hydrographic temperature series of the Finlandish Hydrographic Commission. It can be foreseen that these questions will attract great interest in the future.

This paper is not a treatise upon oceanic circulation in general, but a study of one of its causes, viz. the influence of ice-melting. The first clearly expressed suggestion that the melting of ice in sea-water must occasion a movement of the surrounding water, I have found in a treatise of F. L. Ekman. The first diagram

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* "Ueber die Beziehungen zwischen hydrographischen und meteorologischen Phänomenen," *Meteorologische Zeitschrift*, August, 1896, pp. 285 and 310.

† O. Pettersson, "Hvilka äro orsakerna till vegetationsperiodernas tidigare eller senare inträdande under olika år?" *Svenska Landtbruks-Akademiens tidskrift*, 1899, H. 1, p. 3.

‡ N. Ekholm, "Sveriges temperaturförhållanden jemförda med det öfriga Europa," *Ymer*, 1899, ii. 3, plates v. and vi.

§ Meinhardus, "Der Zusammenhang des Winterklimas in Mittel- und Nordwest Europa mit dem Golfstrom," *Zeitsch. d. Gesells. f. Erdkunde*, Berlin, xxxiii., 1898.

‖ W. Brennecke, "Beziehungen zwischen der Luftvertheilung und den Eisverhaltnissen des Ostgrönländischen Meeres," *Ann d. Hydr.*, xxxii. (1904), ii. p. 49.

¶ O. Pettersson, *Met. Zeitsch.*, Aug., 1896, *l.c.*, p. 300–302.

** "Om de strömningar som uppstå i närheten af flodmynningar, etc.," *Öfvers. K. Vet. Akads. Förhandl.*, 1875, No. 7, p. 98. Ekman points out that a surface current emerges from ice which melts in sea-water. Water from the deeper layers is attracted

of deep soundings which reveals the fact that a layer of warmer water is found at a certain depth under the surface of the ice-filled regions of the ocean, I have found in the Reports of the *Challenger* observations * in the Antarctic ocean.

The way to penetrate further into this subject seems to be twofold: We must determine the accelerating forces existent in the water itself from simultaneous observations of the density at different depths in the ocean over a large area. With these observations we must combine measurements of the actual direction and velocity of the movement of the water in all depths.

From both kinds of observations combined we shall be able to draw important conclusions as to the relative influence of the physical and the mechanical causes of oceanic circulation. The first "synoptic" material is, for a certain part of the ocean, provided by the international investigation of the sea. The second can only be collected by the use of current-meters of modern construction. I shall be glad to put an instrument of this kind at the disposal of the first expedition that will undertake the grateful task of determining for the first time the under-currents of the ocean between the Açores and the African coast, or between Rockall and Ireland, or between Iceland and Jan Mayen from an anchored boat or buoy.

REVIEWS.

EUROPE.

Flora of the Alps.

'Geschichte und Herkunft der Schweizerischen Alpenflora. Eine Übersicht über den gegenwärtigen Stand der Frage, von Marie Ch. Jerosch.' Leipzig: W. Engelmann. 1903. Pp. vi. and 253.

The book before us is the result of a searching inquiry into the history and origin of the flora of the Swiss Alps, it being the intention of the authoress to show what is our present knowledge of the subject.

During the Miocene epoch the plains were covered with a subtropical vegetation, of which now fossil remains only are found; the alpine parts of Eurasia and North America were, however, producing analogous alpine floras. During the first glacial epoch, the plants were driven from the high mountains—except, perhaps, a few well-sheltered individuals—down into the plains. The northern forms also moved towards Central Europe. A tundra was thus formed between the ice of the north and that of the alpine districts, of which we have fossil remains preserved. When the ice again retreated a general exchange of plants took place, and Arctic plants went into the Alps, and alpine plants passed to the north. Therefore, in addition to the few Tertiary alpine plants, which were not driven down by the ice, we get in the Swiss Alps arctic and alpine plants from various sources. Such an exchange took place after every one of the three ice ages. After the third ice age, the exchange was so great that the limits of the various periods cannot now be properly traced.

The interglacial periods are shown, from the nature of the fossil plants found, to have been much warmer than to-day, and the persistence of the Tertiary alpine

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to the spot by "reaction," *i.e.* by the influence of the friction of the outflowing surface water. Ekman declares, however, that the influence of ice-melting upon the oceanic circulation is insignificant in comparison with the effect of rainfall, evaporation, etc.

* '*Challenger* Reports.' J. Murray on "The Deep and Shallow Water Marine Fauna of the Kerguelen Region of the Great Southern Ocean," *Challenger Reports*, vol. xxviii. part ii., No. 10, p. 349.

plants in the Swiss Alps during these periods is another reason why it is not now easy to make out the influence of each separate glacial epoch.

The apparently mysterious and local occurrence of certain species may be due to the wind, especially in the case of hill-sides exposed to southerly winds, which are apt to produce Mediterranean forms. It may, however, be due to historical causes, the ice persisting longer in one place than another, or finally to modern ecological conditions. Changes are brought about now by the cutting down of forests, which results in the formation of new localities. The continual cutting of the grass may turn a flowery alpine mat into a monotonous carpet of Gramineæ. The nibbling by cattle has the same effect. The influence of man, in limiting the area of distribution of certain species, is, however, still little felt in the Swiss Alps. But disregarding even this influence, the flora and vegetation of the Swiss Alps has not yet quite settled down.

O. V. D.

Central Italy.

'Hill Towns of Italy.' By Egerton R. Williams. Smith, Elder & Co. 1904. Pp. x., 398. *With a Map.*

This book demands neither detailed criticism nor much praise. It is a *congeries* of impressions, not particularly illuminating, on certain towns in the hills between Florence, Urbino, and Rome; some of them, it is true, but little visited, others of too high a fame to need the delineation of the impressionist. The book becomes interesting at one point, however. This is when the author was guided, in the neighbourhood of Viterbo, to a locality, little known on account of the brigandage prevalent until recent times, where an early Roman or Etruscan bridge was found to lead to a town wall almost covered by underwood. What lay beyond it was not ascertained, but it was enough to suggest that exploration (apart from excavation) is still to be carried on in Italy. But it is a sorry task to follow an archæologist who is content with the statement that the palace of the Farnese at Caprarola was built "a century or two later" than the castle of the Orsini. The book is illustrated with very beautiful photographs, some of which admirably show the striking positions of these rightly named "hill towns."

O. J. R. H.

Geology of Bosnia and Herzegovina.

'Geologischer Führer durch Bosnien und die Hercegovina, herausgegeben anlässlich des IX. internationalen Geologencongresses von den Landesregierung in Sarajevo.' By Dr. Friedrich Katzer. Pp. 280.

Though ostensibly a handbook for the use of members of the International Geological Congress of 1903, who took part in the excursion through Bosnia and Herzegovina, this book is of more permanent interest as an interesting and well-written introduction to the geology of these countries. Prefaced by a general description of the geology of Bosnia and Herzegovina as a whole, the greater part of the book is devoted to a description of the route followed by the excursion, which is mainly geological, but contains some information of more purely geographical interest. We may specially mention a very interesting account of the iron industry of Vares, where over 40,000 tons of charcoal iron are produced annually, together with a brief history and description of the antiquated methods of manufacture which have been supplanted by a more modern system; of the great travertine terraces of Jajce; and of the Popovo polje, one of those remarkable depressions in the limestone country of Herzegovina, which are watered by subterranean streams, and alternately lakes and fertile plains, with the rise and fall of the waters. An excellent index adds largely to the utility of the book.

R. D. O.

ASIA.

Japan by Letter.

'Present-day Japan.' By Augusta M. Campbell Davidson, M.A. Fisher Unwin. 1904. Pp. xiv., 331.

There is something very attractive about the well-written letter as a medium of conveying general impressions of travel. Miss Davidson did not suppose, when writing her letters, that they would make a volume; but it is well that they have been caused to do so. They have the additional advantage of having been carefully relieved of matter of purely personal interest, and have been run together in consecutive narrative form. The writer is certainly a model correspondent. Her powers of observation are of the keenest, and are not merely superficially applied. The most instructive and erudite chapter is certainly the last, in which the Japanese drama is described and its evolution discussed; but as there is not yet a science of histrionic geography, this, the most praiseworthy section of the book, may be passed with mention. Like the majority of travellers in Japan, Miss Davidson has been imbued with the interest provided by the people, their life, history, traditions, and religion, somewhat to the exclusion of description of the country from her letters. Street scenes in the towns, life in the country inns, flowers and trees, and Fujiyama, we have as usual. A picture of the country apart from its people and their works is lacking, but this can be forgiven a correspondent so clear and enlightened. O. J. R. H.

Geology of Japan.

'Outlines of the Geology of Japan.' Descriptive Text to accompany the Geological Map of the Empire, on the scale 1:6,000,000. Compiled by the officials of the Imperial Geological Survey of Japan. Tokyo: 1902. Pp. vi. + 251.

The authors of this book have interpreted its scope, as an accompaniment to the first tolerably complete geological map of Japan, too literally to make it a connected and interesting account of the geology of Japan, but have succeeded in producing a very useful summary of what is known of the exposures of the various geological formations which are found in Japan. To a large extent the fault which has been found, if fault it be, is inherent in the subject, for the great apparent simplicity and unity of the great curve of the Japanese islands finds no reflection in their structure. They are remnants of an old land surface, the greater part of which has now sunk beneath the sea, and the great dislocations which caused this breaking up, none of them older than the Tertiary era, are independent of and cross, more or less obliquely, the structure lines displayed in the islands, and the unsubmerged remnant of land is divided into a number of geological areas, with so little unity that the principal structural break crosses the main island, dividing it into two halves, which contrast as strongly in geological structure as in surface features. One result of the geologically recent formation of the Japanese islands, by submergence, is their large number; those exceeding 4 kilometres in circumference being over four hundred in number, while the length of coast-line exceeds the circumference of a circle of equal area in the proportion of 12·8 : 1, and to this extended coast-line we may attribute the development of those qualities which have made the name of their inhabitants as sailors. Little is seen on land of the fault lines which have determined the general trend of the islands, for they lie beneath the sea, and are in them the origins of the majority of the world-shaking earthquakes which start from Japan. The lines of volcanoes are independent of the structure-lines of the older rocks, and, on the whole, follow the direction of the more recent series of dislocations, with which they seem to

be genetically connected; but it is a mistake to suppose that Japan is all volcanoes. Though 165 are known, of which 54 are classed as active, the total area occupied by volcanic rocks is only 19·16 per cent. of the whole area of the Japanese empire, at its present limits.

More than half the volume is devoted to economic geology, and here, too, the purpose of an accompaniment to the map is strictly kept in view. We have a series of descriptions of individual mines or groups of mines, and only in the case of coal and petroleum is there even an attempt at a review of the production of the empire as a whole. Coal is the most important mineral industry, the production in 1899 having been 6,721,798 tons; of petroleum, the production was less than $\frac{1}{180}$ part of the amount imported. Precious metals were represented by 28,500 ozs. of gold, 1,246,300 ozs. of silver, and 18,300 tons of copper; and in a country containing so many volcanoes, it is not surprising to find that sulphur is represented by a production of 8450 tons. R. D. O.

Bithynia.

'Forschungen auf der Bithynischen Halbinsel.' Von Dr. Rudolf Fitzner. Illustrated. Pp. 183. Rostock: Volckmann. 1903.

Dr. Fitzner, after some residence in Constantinople, undertook, in 1900, an exploration of the small peninsula which immediately faces the capital in Asia and was part of ancient Bithynia. He describes the routes in the first part of his report. They took him as far inland as Adabazar, and enabled him to gain a general idea of the geological structure and actual superficial condition of the country. He summarizes his results in two concluding chapters, in the first of which he makes some attempt to elucidate the problem of the original formation of the Bosphorus. But he admits that he does not solve it, and the map at the end will show how imperfect our knowledge of the relief of the nearest bit of Asia still remains.

AFRICA.

Cyrenaica.

'Cyrenaïka als Gebiet künftiger Besiedelung.' By Dr. Gotthold Hildebrand. With Preface by Dr. Th. Fischer. Pp. xv., 304, *and Four Maps*. Bonn: Carl Georgi. 1904.

This is a careful compilation of the geographical facts recorded concerning the coastal district of North Africa which intervenes between Egyptian and Tripolitan territory. The author has first to define the "Cyrenaika," and tries to show that there is a morphologic unity in all the plateau region which projects like a bastion into the Mediterranean between the Gulfs of Sidra and Sollum, and not merely in the strictly Cyrenaic highlands. The last-named gulf and the Wady Fareg are fixed as the eastern and western limits; the sea is on the north; and a very ill-defined boundary is found on the south in a doubtful line of escarpment running diagonally south-eastward from the mouth of Wady Fareg to the oasis of Siwah (Ammon). This region is generally arable, in sharp contrast to its surroundings, and certain parts of it, especially Jebel Akhdar, on whose crown lay ancient Cyrene, and the small deltaic plain of Derna, are distinctly rich. The purpose of the book is to illustrate the capacity of a not distant, but singularly ill known land to receive and support European colonists; but it has been written in ignorance of the actual process of colonization which has been going forward in the Cyrenaica these two years past. The German, Italian, or British settlers, expected by the author, have in fact been anticipated by Cretan Moslems, planted

by a paternal government on various points of the coast from Tobruk to Bengazi, and in other inland localities, *e.g.* 'Ain Shahat, Cyrene itself. These laborious and careful agriculturists, former owners of the richest Cretan lowlands, are even now reintroducing a settled element into a nomadized country, and making parts of it bloom as of old.

The author lays stress on the central situation of the Cyrenaic projection in relation to the East Mediterranean basin, but admits its grave lack of coastal advantages. As a matter of fact, there is no safe anchorage for a vessel of even moderate burden at any point of the Cyrenaic shore, except Tobruk. The fortnightly Italian steamer, which alone serves Bengazi and Derna, has often to omit its visits; and the old port of Cyrene, Apollonia, now Marsa Susa, offers an even more dangerous roadstead. On the inland side, also, though Dr. Hildebrand shows that the Cyrenaica offers a much nearer outlet to the central North African trade in ivory, ostrich feathers, etc., than either Alexandria or Tripoli, he admits that the desert spaces to be traversed in passing from Wadai to Bengazi are so formidable, that the slightest inducement or pressure diverts caravans from that route. He hopes, however, that a railway may some day be made from the Cyrenaica to Chad. By stating these advantages and disadvantages, he incidentally shows why ancient Cyrene had so brilliant, but so short a life. So soon as Egypt was Hellenized on the one side and Tunisia Romanized on the other, Cyrene lost the place which had been hers while she was the one European settlement of importance in North Africa. Natural conformation tended to make what Central African trade there was flow towards Berenice (Bengazi), and the more fertile plateau, farther advanced with the Mediterranean, lapsed to the desolation which now possesses it. Though the strong coastal currents tend to neutralize the formation of littoral plains, the soil of the plateau is deep and rich, the climate is temperate, and, despite the prevailing limestone structure, springs are comparatively abundant. To the four fountains of Cyrene enumerated by the author we can add a fifth on the north-east of the site, and we believe there are others on the ridge eastward.

Dr. Hildebrand has compiled from travellers' and consuls' reports statistics of production, and promises a future for several cultures, especially the olive and barley. But we doubt if the statement made by a French writer in the seventies, that the Cyrenaic grain was in great demand by British brewers, was worth repeating. The only faults we have to find with this useful book are that its author uses all sorts of authorities with little discrimination, and does not give quite enough information about them. For example, the list of works bearing on the Cyrenaica, given as an appendix, would be ten times as useful if there were some classification, involving statement of which are of first-hand and which of second-hand authority, and to what parts (if any) of the country their authors had penetrated.

D. G. H.

The Sudan in the Making.

'The Binding of the Nile and the New Soudan.' By the Hon. Sidney Peel. Edward Arnold. 1904. Pp. vi., 288. *With a Map.*

Mr. Peel has a happy simile for the New Sudan. "No one," he says, "whose lot it has been to travel through the night on the plains of a tropical country can forget the amazing effect produced when the sun, with one great leap, as it seems, springs clear above the horizon. And in a moment the world's face is altered." So appears the Sudan, peaceful and progressive, where "the din of battle has hardly ceased to echo." Whether on the subject of the newest benefits wrought upon Egypt by recent irrigation schemes, or on that of the Sudan under British rule,

the story is very pleasant reading. As regards the binding of the Nile, former and present systems of irrigation, the construction and working of the Assuan dam and the new barrages, and the clearing of the sudd, are here described very thoroughly, but without technicalities unintelligible to the ordinary reader. Passing to the Sudan, Mr. Peel gives two grim chapters on its history; then follows the simile quoted. The horizon lightens, as he describes, the Phœnix-like town of Khartum, already beautiful in its new birth. From it he shows the development of the region in every direction—in administration, educational development, commerce and agriculture, finance. This is a record of steady yet wonderfully rapid progress. In the hope and belief that this progress will continue, the book may be characterized as essentially one of the moment, but for the moment it is very well worth reading. The map is a coloured diagram, according to which there are a mountain or two west of Fashoda, but none at all in Abyssinia.

O. J. R. H.

AMERICA.

Ulrich Schmidel and the La Plata.

'Viaje al Rio de la Plata (1534–1554), notas bibliográficas y biográficas por Bartolomé Mitre.' Prólogo, traducción y anotaciones por Samuel A. Lafone Quevedo. Buenos Ayres: Cabaut y Cía, Editores.

This is the first volume of the "Collection of rare or inedited books upon the region of the Rio de la Plata" which has been published under the auspices of the Junta de Historia y Numismática Americana, of Buenos Ayres. This new society has a splendid field for its labours, and we may expect results of great historic, ethnographic, and geographical importance from its researches under the able leadership of its president, General Bartolomé Mitre, so well known as a soldier, statesman, and historian. Its list of "active members" comprises some of the best literary and scientific talent of the Argentine Republic.

Fortunately, three adventurous soldiers, at the time of the Spanish conquests in the New World, were impelled to chronicle their experiences and describe the countries through which they marched—Bernal Diaz del Castillo in Mexico, Pedro de Cieza de Leon in the Andean region, from Panamá to Chile, and Ulrich Schmidel in the Plata valley. The first wrote fifty years after the conquest of Mexico. His was the simple narrative of an old and honest soldier who had faithfully followed Cortes, even in his Honduras campaign, and whose scars were the principal reward that remained to him from the 119 engagements in which he had displayed his exhaustless valour. In homely but convincing language, he frequently contradicts the statements of his overshadowing companion Gomara, whose polished and flattering pen could hide the failings of Cortes in the splendour of his remarkable exploits.

Cieza de Leon, gifted with rare powers of observation and good judgment, launched himself into the whirlpool of plunder and greed at the isthmus of Darien when only fourteen years of age, and took part for several years in its scenes of broil and battle. His works might well be called the Exploration and Geography of the Andean region. From the moment he decided to chronicle his experiences and to describe the country and its people, he never faltered in his arduous and self-imposed task. The reason which he gave for assuming this was, "that in all parts where I had been no one was engaged in writing anything concerning what had occurred, and time destroys the memory of events."

Of these three great chroniclers, Ulrich Schmidel ranks lowest in point of literary merit, but his work is invaluable, and this humble, common soldier is

justly characterized as "the first historian of the Rio de la Plata." Mitre says of him, "He relates events dryly and concisely, fixes dates, determines distances, describes what he sees according to his understanding, without ornament of style or deviation. He only occasionally forms a judgment, makes a reflection, or gives ethnographic data, statistics, astronomic or of natural history. In a few strokes he presents us with a picture, sketches a district, describes an animal or plant, gives us an idea of races and lost customs, supplying at the same time precious elements for the chronology and initial history of colonization of the Rio de la Plata by the European race."

The octavo work under review devotes some 30 pages, by General Mitre, to the biography of Schmidel, giving evidence of profound and laborious research. It is accompanied by Schmidel's genealogy from 1364. In a prologue of about 100 pages, the translator, Prof. Lafone Quevedo, analyzes the narrative of Schmidel, and compares his statements, especially those relating to geography and ethnology, with all of the data relating to the country and its Indian tribes which have been accumulated by the linguistic section of the Museo de la Plata over which he worthily presides. He thus elucidates the relation of Schmidel, and makes it doubly interesting to the student of the discovery and conquest of South America.

An appendix of 100 pages contains ten historical documents, most of them not previously published. Upon these are founded many of the arguments of the prologue. Besides eighteen plates, reproduced from the old Latin edition of Hulsius, there are three maps, one from Hulsius, another the Gran Chaco of Jolis, which is one of the best ethnological maps of the eighteenth century, and a third which is from the original map of Delisle, which, although of date 1700, probably represents information gathered in the sixteenth century.

In comparing this new Spanish translation with the English one published by the Hakluyt Society in 1891, under the title of "The Conquest of the River Plate," we are struck by the elaborate care which has been taken to verify the statements of Schmidel with information gathered from every available source. The translation has been made from the latest German edition, and confronted with all of those which have preceded it, the first of which was published in 1567 from the original manuscript of Schmidel in German. This abounds in orthographic errors, making the names of persons, tribes, and places unintelligible.

It was from the edition of 1567 that the English translation was made, faithfully adhering to the text without rectification, except in part by explanatory notes. The brilliant introduction was by Don Luis L. Dominguez, who, according to Prof. Lafone Quevedo, severely criticized Schmidel for many of the defects in his narrative for which he was not responsible.

The literary movement in the Argentine Republic is remarkable. A group of highly cultured writers, in the city of Buenos Ayres, has already made that great and thriving emporium the principal seat of learning of the southern half of the New World. The numerous works which they have published abound in valuable information, especially regarding the history of the Spanish colonial period, and the geography and ethnology of South America. They are characterized by admirable freshness of thought and broad liberal views. The volume before us is one of the many proofs of this, and makes us hunger for a second one from the Junta de Historia.

GEORGE EARL CHURCH.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Desert Flora.

'Desert Botanical Laboratory of the Carnegie Institution.' By F. V. Coville and D. T. MacDougal. Washington: the Carnegie Institution. 1903. Large 8vo, pp. 58. 29 *plates*, 4 *figures in the text.*

Botanists going to the tropics generally choose those districts for carrying out research in which the conditions affecting plant-life are favourable. For this there are two reasons. The scientist, on the one hand, naturally desires to see the tropical flora in its highest and most luxuriant development. On the other hand, botanists who are sent out by their Governments for the purposes of economical research, naturally go to districts where the conditions are such as to make the cultivation of useful plants possible. It is thus that the investigation of the desert flora has been very much neglected, the plants of the desert making a poor show for the botanist travelling abroad for the first time, and they are of no great value to the practical botanist. Our knowledge of tropical rain-forest vegetation is already very extensive, and there are quite a number of laboratories at which work, economical and scientific, can be carried out. Although some work on desert plants has been done—and I need only mention here the name of one author, Volkens—the conditions of plant-life in the desert are still almost unknown.

The establishment of a Desert Botanical Laboratory by the Carnegie Institution therefore marks the extension of botanical research in a direction hitherto but too much neglected. The laboratory is situated near Tucson, Arizona.

We have before us the first report of this Laboratory, which may thus be said to be in working order. The report first contains a few introductory remarks on the history of the movement to establish a desert botanical laboratory, the object of which should be "to thoroughly study the relation of plants to an arid climate and to substrata of unusual composition."

About twenty pages are taken up with a description of the places visited during the laboratory location trip, the remaining part of the report being devoted to a few brief botanical, meteorological, geological, and other observations, which must be considered to be of a preliminary nature. The report is illustrated by a number of very good reproductions of photographs, one of which (plate 11) shows the new laboratory, nestling on the slopes of the Tucson mountain, and surrounded by a typical desert vegetation, of which grand cactuses, 20 to 30 feet high, form a very prominent feature. O. V. D.

The Atoll of Funafuti.

'The Atoll of Funafuti. Borings into a Coral Reef and the Results.' Being the Report of the Coral Reef Committee of the Royal Society. Published by the Royal Society. 1904. Quarto. Pp. xiv., 428. *With* 29 *Maps*, 6 *Plates*, *and* 69 *Cuts in Text.*

Perhaps a feeling of keen disappointment cannot but dominate as one turns away from the account of the work of the Funafuti expeditions. A full account of a boring successfully put down to a depth of 1114½ feet is before us, but yet the question of the formation of atolls in general—and one might almost add of Funafuti in particular—is in the same position as it was in 1903. No fault can be found with the conception of the work, nor with the mode in which it was carried out. Some of the ablest men of England have ungrudgingly given their time during the last seven years to the task of examining the materials, but yet the fact remains that not a single one of the important questions, in connection with the formation

of coral reefs, has been definitely solved. This result may be due to the choice of Funafuti as a typical atoll, but in 1895, when the first expedition was arranged, the wide differences which we now know to exist between reefs were not anticipated.

Time and money, however, have by no means been wasted. Our disappointment is unjust, due to an unreasoning anticipation of definite results, and with the facts before us will be readily dispelled. For the first time a vertical section of over 1000 feet of the limestone of a coral island is portrayed with such minuteness of description and wealth of detail, that we can each draw our own inferences. The editor prefers to leave it thus without giving his views, perhaps a wise decision in view of the contradictory nature of the evidence, and the very numerous additional points on which we *now* desire information. While we may criticize one point or another, we freely recognize the enormous value of the solid mass of fact, which forms the greater part of the volume.

The first expedition, in 1896, under Prof. Sollas was a failure, putting down two bores of only 105 and 72 feet, owing to the gear having been unsuitable to the unexpectedly cavernous nature of the rock. Captain A. M. Field and the officers of H.M.S. *Penguin*, which carried the expedition, made a thorough and minute survey of the atoll, a comparison with which in twenty-five or fifty years may be expected to yield valuable results. A second expedition in the following year, under Prof. David, reached a depth of 698 feet, and was responsible for a large-scale geological map of the encircling reef, based on the topographical survey of the Admiralty. Finally, the boring was completed in 1898 by Mr. Finckh, who also gives us a biological account of the whole reef-formation.

The most interesting of the preliminary reports is that of Prof. David on the geology of the atoll, in which he contends that its somewhat peculiar shape has been determined independently of the direction of the prevailing winds and currents. The visible foundation rock of the greater part of the reef platform is formed of Heliopora and Porites *in situ*. Since the time that these corals flourished there would seem to have been at least three oscillations of level, two upward separated by a downward one, the last, as shown by the level of the land, a sinking of the shore-line for at least 14 to 16 feet, due to an elevation of the whole atoll reef or a drawing away of the sea. It is suggested that the same sinking of the shore-line still continues, though it is difficult to understand why it is accompanied by a general denudation of the land, the materials of which are being washed into the lagoon. If this is the case, and if the last movement, as is supposed, is still in progress, the lagoon should be silting up, but it scarcely appears to be so except in certain protected situations, where the effect is due mainly to the growth of Halimeda, a frondiform calcareous alga, and the deposition of foraminifera. This relative absence of silting is mainly ascribed to the tidal scour, which is stated to have caused a deposit of about 300 feet in thickness off one of the western channels of the atoll. Perhaps the scour is also responsible for the submarine cliff of 1 to 4 fathoms which in most places bounds the lagoon. The observations that angular rubble, "even when bedded in water subject to swift and variable currents, came to rest at angles at least as high as 40°," and that "the foraminiferal sand rests at an angle of 33°, even when bedded in the moving tidal water," have an important bearing on one view of the formation of coral reefs, as does also Prof. David's conclusion that such angular material "may attain a dip of 60° or 70°, or even become vertical, through becoming cemented by" various organisms. Further, the action of humic acid in the formation of sandstone and of depressions in some of the encircling island is not without interest in connection with the solution hypothesis of lagoon-formation.

The cores and other materials from the borings have been worked out under the

direction of Prof. T. W. Judd, who is also himself responsible for their chemical examination, while the mineralogical changes have been undertaken by Dr. Cullis. Of greatest interest to the students of the coral-reef question will be Dr. G. J. Hinde's 'Report on the Materials of the Borings,' 176 pages, mostly of small type. A work of such magnitude, of such difficulty and novelty, and of such a minutely detailed nature has never before been attempted. The examination of the core from the main boring entailed the preparations of upwards of 1100 really separate reports and the identification of many thousands of organisms, while accounts are also given of the two first borings and of those in the lagoon. In all about 400 feet of core were obtained, varying in diameter from 4 inches to $2\frac{1}{4}$, every piece of which had to be sectioned and minutely examined. In truth, Dr. Hinde is to be congratulated on the completion of his great task, and in having contributed to science a standard work of the highest permanent value. We would only venture to suggest that the addition of a few plates of representative sections of the core at different levels would have made the description more graphic and much simpler to readers, who are not specialists, and would have enabled them the more readily to have appreciated the various points which arise.

The result of the examination of the materials may be best expressed in Prof. Judd's words: "Dr. Hinde's carefully drawn up lists show that from top to bottom (of the core) the same organisms occur, sometimes plants, sometimes foraminifera, and sometimes corals predominating; but in the whole depth bored the same genera and species of the various groups of organisms take their part in the building up of the mass." *But does the boring run through a talus slope or a reef that has gradually subsided?* Unfortunately, Mr. Finckh's somewhat scanty account of the biology of the atoll is of no value to us, since the conditions governing it have greatly changed owing to the recent oscillations of level. A little dredging was due on the outer slope as deep as 200 fathoms, but it was too slight to be of much real value. The ordinary consolidating organisms may—and it is stated that Lithothamnion, the most important, does—live down to the required depth, and, further, a talus may, according to Prof. David, be formed even vertically. The latter conclusion largely invalidates any deductions from the statement that the corals of the core are very frequently in their growth-positions. Further, sedentary organisms, and particularly corals, appear to be so difficult to orientate that the full evidence of growth-position might have been given with advantage in a few of the best cases, with perhaps sections of the core. Considering the peculiar nature of the core down to about 750 feet, and its complete consolidation thereafter, and also its small size, it seems dubious whether the presence or absence of definite stratification could have in any case been determined or even expected. Indeed, the report seems to give no answer to our question, though there is much in it which may be quoted—and questioned—in accordance with the views and knowledge of different observers.

In conclusion, we may again be permitted to emphasize the great permanent value of the whole report. It is ably edited by Prof. Bonney, and is throughout characterized by a complete freedom from bias of any sort. It is the centre from which future research will largely radiate, and with it as a basis we may expect a flood of light from the examination of elevated coral reefs and limestones all over the world. The more the various reports on the cores are studied, the more will their immense value be recognised.

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

The Mediterranean Region.

'Das Mittelmeergebiet—Seine geographische und kulturelle Eigenart.' By A. Philippson. Pp. vi., 266. *Illustrations and Maps.* Leipzig: Teubner. 1904.

A well-known writer on the physical characteristics of the Greek peninsula makes herein a useful contribution to regional geography by treating the Mediterranean with its islands and coasts as a whole. The frontiers of his *Mittelmeergebiet* are, perhaps, somewhat vaguely drawn; for by no means does he take account of all the hydrographic basin of the Middle Sea, nor even of the orographic limits which he himself prescribes. For instance, neither the Alps nor the main chains of the Balkans, though assumed to bound the region, are reckoned as part of it; and this being so, it is difficult to see why the Atlas, and the internal plateau of Asia Minor, should, nevertheless, come into the author's purview. If the extent of *hinterland* to be included is somewhat arbitrary, it is, however, not less useful to have a comprehensive consideration of the sea itself with its shores. Dr. Philippson finds a geological unity in the region by regarding it all as a "Bruch-zone," included within one volcanic area, which may be distinguished into a western and an eastern sub-area; and as characterized in great part by a common earth-movement, viz. subsidence. Evidence that coastal movement on a large scale in certain parts of the region did not cease with the post-Pliocene epoch, but has continued in historical times, and is probably going on still, accumulates fast. We have had before us recently Mr. Günther's observations upon the Neapolitan seaboard; the archæologists have been demonstrating still more lately the subsidence of the Nile delta in post-Roman times; and we have ourselves observed indubitable evidence of the same movement on the Cyrenaic shore.

Dr. Philippson classifies the borders of his sea into *Schwemmlands-Kuste*, *Erosions-Kuste*, and *Ingressions-Kuste*. A better classification might be dual, the true distinction being between the first and third. "Erosions Kuste" results from a secondary process, which modifies coasts formed primarily under one or two other of the remaining heads. But, at any rate, Dr. Philippson's classification serves to distinguish obvious varieties. A more serious objection might be found in the general unevenness of treatment, noticeable in this book. At least twice as much space, attention, and detail are devoted to the eastern Mediterranean as to the western, doubtless because the author has much more intimate personal acquaintance with the former area. The Spanish, French, Italian, and African coasts are surveyed very cursorily, and the treatment only becomes satisfactory when the Adriatic and the Ægean are reached. Further, it is perhaps inevitable that such a general treatise as this should err on the side of generality. Certain distinctions of climate and life-distribution are too sweeping. For instance, central Asia Minor is neither so rainless nor so thinly populated as it is described in Dr. Philippson's text, or represented in his charts. The truth is that we have not yet enough *data* for several of the Mediterranean lands to allow of their being classified on broad lines with that hard systematic precision dear to German science.

With this warning, however, we can heartily recommend Dr. Philippson's book to those who wish to study or to teach the geographical conditions of the Mediterranean lands in their bearing on a long and intricate history. As is right and proper, the author always keeps the historical records in view, and uses them where possible, as, for example, in discussing the question of recent climatic change in the eastern basin.

GENERAL.

The Turkish Empire.

'Auf Turkischer Erde.' By Hugo Grothe. Pp. 455, 2nd edit. Berlin: Allgemeiner Verein für Deutsche Litteratur. 1903.

This pleasantly written book of travel over paths for the most part well trodden in the near East, reaches a public which a more serious work would not interest. Dr. Grothe has visited various parts of the Ottoman empire during the past ten years. In 1895 and 1896 he was in Tripoli in Africa; in 1900, in Armenia and Transcaucasia; at other dates, not specified, but obviously recent, in Asia Minor and Macedonia. He was not adventurous, if we may assume that he has described pretty nearly all he has seen; for in Armenia he treats only of the great road from Trebizond to Erzerum; in Anatolia, of the German railway routes to Konia and Angora; and in the Balkan lands, of the railways to Salonica and Monastir, and the caravan road, the old Via Egnatia, to Durazzo. In the town of Tripoli he remained some time, and made one trip on a British grain-ship to Bengazi, and a short excursion into the interior south-west of Tripoli. The result of his leisurely and comfortable journeys is a good deal of encyclopædic information concerning racial types, trade, and superficial aspects of scenery. We do not feel that he has pierced below the skin of things, or is a traveller with much special knowledge of or affinity for the peoples of the near East; but he has observed sympathetically and described readably. Perhaps his most interesting chapter is devoted to a visit to the German religious colonies in Transcaucasia. Thither some thousand Wurtemburgers betook themselves about the same time and with the same purpose as the German colonist who settled near Carmel, and there they still await the beginning of the Millennium.

British Commercial History.

'Queen Elizabeth and the Levant Company.' A Diplomatic and Literary Episode. By the Rev. H. G. Rosedale, D.D.

A very small part of this book can be said to come within the purview of a geographical journal. The "Worshipful Company of Merchants trading to the Levant Seas," was not, like some other merchant companies, an exploring association. Its foreign factories were few, and fixed in well-known trade centres, like Constantinople, Smyrna, Aleppo, and Alexandria. The freemen, as a whole, showed no great enterprise or pioneer spirit, and mostly waited for trade to come to them. They were, in short, rather shippers than exploiters, and, with a few notable exceptions, such as Salt of Cairo, and Barker of Aleppo, took little trouble to inform themselves upon, or open out the lands lying behind the coasts. Powerful at first to introduce British sea-borne traffic to new waters, and extend British political influence, the company somewhat outlived its usefulness; and by the end of the eighteenth century was generally regarded as an abuse, a hindrance to commercial expansion, and a drain on the resources of England. Mr. Rosedale has exhumed a document from the Record Office, which bears upon the early history of the Merchant Association, out of which the company grew, but is not of much importance. He has reprinted a little from Hakluyt, and a little from published Venetian archives, and added some portraits and excerpts from contemporary bills of lading, which illustrate the operations of the earliest Turkey merchants. The whole makes a book which strikes us as not very necessary.

THE MONTHLY RECORD.

EUROPE.

Proposed Ship-canal from the Rhine to the Danube.—A recent Foreign Office report by Dr. F. Rose (Misc. Series, No. 613) gives particulars of the project now under consideration for the connection of the Rhine and the Danube by a ship-canal by way of the Neckar. The writer points out the unfavourable position at present occupied by the kingdom of Würtemberg as regards communications, situated as it is off the main highways leading from east to west, and from north to south. If, on the other hand, the double project of the canalization of the Neckar and the subsequent connection of the Rhine and Danube systems were carried out, Würtemberg would be transplanted into the middle of the largest and most important European waterway. From Mannheim to Heilbronn, and from Heilbronn to Cannstatt or Esslingen (the former just below, the latter above, Stuttgart), the bed of the Neckar would be utilized, and from Neckarems (a little below Cannstatt) to the Danube, those of the Rems, Kocher, and Brenz. The total cost is estimated at about £7,000,000, of which some £2,000,000 would go to the canalization of the Neckar. It is, however, thought that the creation of the necessary locks would yield, in the resulting water-power, an asset valued at about £1,300,000. The length from Mannheim to Neckarems would be 110 miles, and thence to the Danube 71½, in all 181½ miles. Among the advantages to Würtemberg likely to accrue from the construction of the canal are enumerated the reduction of the price of coal by the access supplied to the Saar and Ruhr coalfields; the means afforded for the direct import of raw cotton from Antwerp and Rotterdam, and for the cheaper export of manufactured goods; the possibilities of through transport along the Danube, Neckar, and Rhine, by which petroleum, raw sugar, wheat, rice, in fact all the products of the near and far East, could be carried at cheap rates from the Black to the North sea. Most of the countries of Central, South-Eastern, and Western Europe, including the United Kingdom to some extent, would benefit by the execution of the project, which is favourably regarded by both Baden and Bavaria, as well as Würtemberg. Of great importance to Bavaria would be the access afforded to the upper Rhine, and the connection with the existing French and Alsace-Lorraine canal system on the one side, and with Russia, Austria Hungary, and the Balkan peninsula on the other; while the whole of the south of Germany would come into closer touch with the lake of Constance, East Switzerland, and even with Italy. A somewhat similar project has been set on foot in Bavaria for the junction of the Rhine and Danube by the Main, but this is not regarded as a competitor, but rather as complementary to the other.

Is Rumania in the Balkan Peninsula?—M. Alexandre Sturdza, a member of the Rumanian Geographical Society, in a paper lately read before that body, seeks to combat the common practice of classing Rumania as a portion of the Balkan peninsula. The paper has aroused considerable interest in Rumania, and has been printed in French for distribution abroad, with a view to making M. Sturdza's contention as widely known as possible. The writer first discusses the use of the term Balkan peninsula, which he holds is itself unsuitable, the substitute which he suggests being the somewhat cumbrous one "Thraco-Illyrian peninsula;" but apart from this question, he holds that the only lines which could be held, on scientific grounds, to bound the peninsula on the north are either the Balkans themselves or the Danube. Both the geological history of the region and the existing nature of the surface forms are held to sharply differentiate the lands dominated by the Carpathians from those south of the Danube. The Balkans

are shown to be more ancient than the Carpathians, and to have formerly belonged to the mountain system which included the Crimea and the Caucasus, while the Carpathians belong to the same orogenic system as the Alps. The hydrographical system of Rumania differs in character from that of the Balkans, no less than the relief and the nature of the soil, while the formation of the modern valley of the Danube, by the fracture at the end of the Tertiary epoch which gave rise to the Iron Gates, has supplied a natural dividing-line between the regions to the north and south of it. Finally, the ethnological characters of the population are held to differentiate them in an equally marked way from those to the south of the Danube. There is certainly considerable weight in M. Sturdza's contentions, but it is to be feared that the convenience of grouping together, for ordinary purposes, the whole of the nationalities to the south of Austria-Hungary and South-West Russia, and the difficulty of allotting, in ordinary atlases at least, separate sheets to each of them, will be an obstacle in the way of the reform advocated.

Forestry in Iceland.—The present position as regards possibilities of tree-planting in Iceland is summed up in *Globus* (1904, No. 16) by M. Lehmann-Filhés, on the basis of investigations by C. V. Prytz, professor of forestry at Copenhagen, who has lately travelled in the island with a view of studying the question on the spot. After referring to the old idea that Iceland possesses a single tree only, the writer quotes extensively from Dr. Thoroddsen to show that woods containing trees of some size do exist in various parts of the island, the climate and soil of which are by no means unfavourable to tree-growth. Evidence, in fact, exists to show that Iceland was once much more covered with trees, which have been exterminated for the most part by reckless cutting and the depredations of stock. The evil effects of this are to be seen in the wide areas of stony ground from which the fertile humus has been entirely removed. Apart, therefore, from the question of the supply of firewood, re-afforestation would exercise a beneficial effect by helping to protect the surface soil, and so favouring cultivation. Prof. Prytz regards the experiment as quite feasible, given a suitable choice of trees and of localities for sowing or planting. He recommends both the planting of trees round the enclosed meadows in the vicinity of farms (as here they would be safe from cattle), and the formation of plantations on the mountain-sides. Something has already been done at Hallormstadur in the way of planting firs and pines, the plants having been obtained from Denmark. Birches already spring up naturally, and it is thought that immunity from destruction by sheep might be gained by sowing these in places where the snow lies deep and long, as it is only in winter when grass is not to be had that the birch appears to be devoured by sheep.

ASIA.

Longitude in Indian Survey Maps.—As is well known, the longitude employed in the maps of the Indian Survey Department has been based on observations made early in the nineteenth century for the determination of the longitude of Madras, which subsequent observations, carried out with improved methods and instruments, have naturally shown to be somewhat inaccurate. But the subject is more complicated than appears at first sight, for not only has the value of the Madras longitude required correction, but the difference of longitude between Madras and Kalianpur—the starting-point of the triangulation—which was originally obtained by triangulation only, has been likewise proved inaccurate as at first assumed. The history of the various determinations of longitude for the purposes of the survey, and the values assumed at different times, is summarized by Major S. G. Burrard in the 'Professional Papers' of the Survey of India (Serial No. 7, Calcutta, 1903). The longitude used for the great Trigonometrical Survey,

which has remained the same throughout, was that obtained by Warren and introduced by Lambton in 1815 (Madras 80° 17′ 21″ East of Greenwich). This value was rendered obsolete in 1877 by the telegraphic determination *viâ* Mokattam and Suez, which differed by 2° 30′ (Madras 80° 14′ 51″), but in view of the certainty that finality had not yet been reached in the process of improvement, no change was made in the longitude employed in the Survey sheets. A still greater approach to accuracy was made by the observations of 1894–96, carried out by Captains Burrard and Lenox Conyngham *viâ* Karachi, Teheran, and Potsdam, to which reference was made at the time in the *Journal* (vol. vi. p. 471; vol. xi. p. 174). This gave the value as 80° 14′ 47″·06. It was usual, after the results of the 1877 observations had been worked out, to append to the sheets of the Great Trigonometrical Survey a note stating that the correction required to make the longitudes accord with the new value of the Madras Observatory was −2′ 30″; the atlas-sheets required a further correction of 1′ 9″. This was, however, not strictly correct, this correction holding only in the case of Madras itself, while for the survey as a whole the correction required was some 7″ less, the difference between Madras and Kalianpur having originally been overestimated by this amount, as alluded to above. Similarly, the correction required to bring the survey into accord with the newest value of the Madras longitude was 2′ 27″, not 2′ 34″, as might have been supposed from a casual reading of the footnotes to the survey sheets (the value of the longitude having been reduced by 4″ as compared with that of 1877). In 1900, the construction of a map of India and adjacent countries on the scale of 1 : 1,000,000 having been decided on, and with it the adoption of a new value of longitude, it became a question whether this should be made to accord with the astronomical value of Madras or that of Kalianpur. The choice fell on the latter, which had likewise been the astronomical origin of latitude since 1840; the result being that the accepted *geodetic* value of the Madras longitude became 80° 14′ 54″ E., while the map of India is placed 7″·14 nearer Greenwich than it would have been had the astronomical value of Madras been taken as the basis. In view of the uncertainty as to the relative accuracy of the two determinations of the difference between Madras and Kalianpur, and the fact that the latter was the starting-point of the whole triangulation, the course adopted was no doubt the wiser, even though it involves the above departure from the astronomical longitude of Madras.

The North-West Frontier Province of India.—The Administration Report from November 9, 1901, to March 31, 1903, estimates the yield for the combined harvests of 1901–2 at only two-thirds of the normal, yet with little difficulty all but 5 per cent. of the fixed land revenue was raised. Pathan agriculture, ignoring the principle of variation of crops, exhausts the soil, which the cultivator does little to reinvigorate. On lands irrigated from mountain streams the silt thrown up suffices in some cases to replenish the soil, but in general scientific cultivation would reap a much larger return. The present sources of irrigation being exploited to the utmost, a project is under consideration for the reclamation of a large tract of land by irrigation from canals from the Indus. A very large proportion of the lands in the province is irrigated from the streams and rivers derived from trans-frontier hills, where the conditions of snow and rainfall vary little, and the lands are practically independent of rainfall within the province. The only important supply of timber has been obtained by the Forest Department from Kagan, where deodar-wood has been floated down the Kunhar and Jhelum rivers. The exploitation of the reserve forests is expected to proceed in the future on a much larger scale than hitherto. In the way of the development of communications, the Ekka road from Murtaza to Wana, through the Gomal valley, is practically completed, except

in certain portions of the Gomal gorge. The canal road to Landi Kotal through the Mullagori country has been nearly completed, and the widening of the track into a cart road is projected. The road connecting Dera Ismail Khan with Zhob through the Chuhar Khel Dhana pass is also nearing completion. The buildings necessitated by the separation of the province from the Punjab are well under way. Militia posts are to be built or reconstructed in northern and southern Waziristan. The Swat and Kabul river canals yielded last year a very considerable profit, while a few irrigation channels, owned by the District Board in Peshawar, have prospered financially. The utilization of the waters of the Indus by means of canals at Pehur and Reharpur is projected. Though accurate figures are not easily obtainable, import and export trade is largely on the increase. The trade over the Malakand since 1895 has increased from 10 to 103 lakhs. The figures for the year show an import trade of 88 lakhs and an export trade of 145 lakhs, an increase of 11 and 24 lakhs respectively on the preceding year. The Pathan tribes being scourged by small-pox, 90,000 vaccinations were effected in 1902. The report includes a useful summary of the geography and history of the province and its recent organization as an administrative unit.

AFRICA.

French Expeditions in the Sahara between Algeria and Timbuktu.—Successful journeys have lately been made by two French parties, under the command of Commandant Laperrine and Captain Thiévenaut respectively, who, setting out from Insalah in the north and Timbuktu in the south, effected a junction on April 16 last at a point some distance south of Timissao. M. Foureau, who communicated the news to the Paris Geographical Society, remarks that this confirms his previous opinion that small parties can move with ease and without danger in that region. Commandant Laperrine's expedition was accompanied by a young scientific traveller, M. Villatte, whose careful work will supply a valuable addition to our knowledge of this previously little-known part of the Sahara. The route followed was roughly parallel to that of M. Foureau himself, and as M. Villatte has laid it down with great care by the aid of astronomical observations (including many of occultations of stars by the moon) as well as by topographical surveys, the mapping of this part of Africa will decidedly benefit by his work. He has also obtained valuable geological results, having studied the Devonian and Carboniferous formations which occur beyond the 26th parallel, and obtained interesting fossils.

The Macmillan Expedition.—Mr. W. N. Macmillan, who last year made an unsuccessful attempt to navigate the Blue Nile downwards from Abyssinia to the Sudan, has now succeeded in making the journey in the opposite direction by way of the Sobat. The ascent of the Baro—the upper branch of this river—was accomplished in launches to the foot of the Abyssinian plateau, apparently somewhat further than the point reached by the Marchand expedition in the *Faidherbe*. The Bure escarpment was climbed without unloading the animals, a fact which seems to show that the path must have been improved since Major Austin's visit—possibly by the Abyssinians sent by Menelik to convey the *Faidherbe* by this route to Adis Abbeba. The expedition was accompanied by Sir John Harrington and several other whites, including Mrs. Macmillan.

Scientific Researches in the Ruwenzori Region.—Some interesting notes on the researches of Dr. David, a naturalist apparently of Swiss nationality, in the Congo forest and the western flanks of the Ruwenzori range, are given in a recent number of *Globus* (vol. 86, No. 4). The traveller has distinguished himself by being the first European to secure a specimen of the okapi with his own

gun, which will permit for the first time an accurate knowledge of the physical characters and general bearing of the animal. According to Dr. David, the specimens which have been set up in this country and Belgium have been incorrectly treated, which, all things considered, is not surprising. The okapi, although a ruminant, has all the bearing of a tapir, not at all that of an antelope. The markings are much finer than those of the zebra, the stripes being black within white, and almost all double. The back is reddish, especially in the male, the ears enormously long, the mane erect. Some specimens of both sexes possess horns, while others are entirely without, and Dr. David is on this account inclined to distinguish two species. The animal stands from 4 to 5 feet high at the withers. Another find which is interesting from a zoological point of view is that of an armadillo 4 feet long, closely resembling its congener of the pampas. It frequently assumes an erect attitude, supporting itself on its tail and holding the tree-trunks with its powerful fore claws. Dr. David has also ascended the western slopes of the Ruwenzori range to a height which he estimates at 16,700 feet, which, if correct, would be the greatest altitude yet attained. His routes seem to have led somewhat to the north of Dr. Stuhlmann's. The range, he says, is composed of a series of ridges of granite, diorite, and diabase, no traces of basalt or porphyry being seen. The snow-level occurs at about 14,500 feet, but glacier-tongues reach down to about 13,000. Two small moraine-lakes were seen, and a little below them was a third lake of milky-green colour, surrounded by thick vegetation; while a fourth, which was fed by glacier streams, was clear, though of a greenish-brown colour, perhaps derived from the neighbouring moorland. Like other visitors to the range, Dr. David attempts to define the zones of vegetation met with, of which he distinguishes six or seven, though the uppermost four, above the zone of bamboos, all form moorland of one sort or another. The *Senecio Johnstoni* was found up to 12,800 feet. There was a striking absence of flowers, and of the lush dwarf vegetation characteristic of the Alps. Trees ascend higher on the wall-like sides and slopes of the mountains than on the crests and ridges, but no distinction could be traced between slopes exposed to wind, rain or sun, and the reverse. The vegetation observed on the glacier-tongues on which 3 feet of new snow was lying was of interest, the *Senecio Johnstoni* growing with its base almost in the ice, and its roots embedded in the ground-moraine, which was frozen at the surface, though of a higher temperature below. Dr. David hopes to continue his researches in this region.

The Flora of Somaliland.—The latest of Prof. Engler's valuable studies of the vegetation of African regions is devoted to Somaliland, the flora of which, as known from the collections brought home by recent travellers, is discussed in the *Sitzungsberichte* of the Prussian Academy of Sciences (1904, Nos. x.–xii.). After enumerating the travellers to whose labours we owe most of our knowledge of the botany of Somaliland, the writer describes in detail the various provinces into which the area may be subdivided from the point of view of vegetation, enumerating the principal forms characteristic of each. It will be sufficient here to note briefly the general conclusions arrived at as to the history and relations of Somaliland flora. As already suggested in Prof. Engler's 'Hochgebirgsflora des tropischen Afrika,' the flora of the *northern* highlands of Somaliland shows some relationship with that of Abyssinia, but, as a whole, a broad distinction must be drawn between the Somaliland flora on the one hand and that of Abyssinia and the Galla highlands, which are themselves closely related, on the other. The almost unbroken band of high ground which runs through East Africa has exercised a marked effect in isolating the Somaliland flora, from which numbers of families and species well represented in other parts of East Africa are entirely wanting, in spite of the

resemblance of climate, soil, and the general character of the plant formations. These missing forms include some typical steppe-plants, such as *Borassus æthiopum*, *Butyrospermum Parkii* (var. *Niloticum*), *Adansonia digitata*, etc. Even the northern uplands show many such negative characteristics. Among the positive characters Prof. Engler notes (in addition to the extraordinary abundance of certain species of succulent plants—*Commiphora* and *Boswellia*) the prevalence of low steppe bush, with an intermixture of isolated tall trees; the abundance of thorns and woody shoots; and, in the driest parts, the formation of short cylindrical or conical stems sending out thin branches. In these respects the flora shows a general resemblance to that of Damara-land, though distinguished from this by a difference of species. A further important element is that of forms belonging to the Eastern Mediterranean flora, which Prof. Engler regards as introduced by the agency of the wind and animals, not as survivals of a more extended flora of this character; the increasing area occupied by steppes favouring the establishment of new species. A different explanation must, however, be given for the occurrence of *Kissenia*, the sole representative of the order *Loasaceæ*, which is so widely distributed in America. Its dispersion must have been a gradual one, and seems to have started from Damara-land, whither it may have made its way in the past from an old land-mass lying between America and Africa. The case of *Kissenia* is one of the many instances brought to light within recent years of the occurrence in Africa (as in Asia) of isolated forms bearing a close relationship to American types.

Navigability of Upper Branches of the Congo.—A careful examination of the courses of the lower Lualaba and Lufira rivers, with a view to test their navigability, was made last year by a Belgian officer, Lieut. Lattes, and the results were outlined in the *Mouvement Géographique* for April 10 and 17 last (with sketch-map). They show that the Lualaba is navigable by steamer between 9° 10′ and 5° 20′ S., although at high water some difficulties occur at the point where the stream makes its exit from Lake Kisale. M. Lattes gives a detailed account of the width, depth, rate of current, nature of the banks, and general aspect of the stream throughout the section examined, and describes especially the *régime* of the river in its passage through the series of lakes and backwaters so characteristic of a considerable part of its course, which serve to regularize the flow and retard both the rise and fall of its waters. Lake Kisale becomes, in the rainy season, an enormous marsh without definite limits, extending from the Lualaba to the Lufira. The floating islands, formed of papyrus and other vegetation, are a feature of the lake, as has been known since Cameron's time. The open water has a depth of 5 to 7 feet, and the lake may be considered navigable throughout the year to steamers drawing 3 feet and less. The lower Lufira is not navigable by steamers when the water is lowest, *i.e.* during September, October, and the first part of November.

Areas of African Territories.—In the latest issue of that useful publication 'Die Bevölkerung der Erde' (*Pet. Mitt.*, Ergänzh. 146), Prof. Supan gives the results of a recalculation of the areas of the political divisions of Africa as delimited by the international agreements of the last dozen years. In certain cases the boundaries are still somewhat indefinite or existing maps defective, so that the figures are still provisional only, but in view of the wide discrepancies in current estimates of the areas it may be of interest to give the figures, converted from square kilometres to square miles. Owing to the uncertainty as regards the boundary between British East Africa and Abyssinia, Prof. Supan has refrained from giving figures for these (except for certain portions of the former), so that he makes no estimate of the total area occupied by the possessions of the several powers. In the table below

this is done by supposing the missing boundary to run in a generally east-south-east direction, from the southern termination of the fixed frontier, to the Jub above Berbera, and estimating the areas of the two territories on this basis. Prof. Supan, on the other hand, has preferred to group the various territories into the three main divisions of North-East, North-West, and South Africa (the last including the whole area south of the northern frontiers of the Congo State and German East Africa). These, the author points out, are completely divided off by definitely fixed frontiers,* and the first two are of some political importance inasmuch as the north-east group is mainly under British influence, the north-west under that of France. The southern division is more composite in character. But as these divisions correspond to no natural regions of the continent, no great interest attaches to an estimate of their respective areas. For the area of the whole continent Prof. Supan has adhered to the figure obtained by Trognitz and given in an earlier issue of the same publication. In the following table the territories definitely under British rule are grouped together first, and those under British influence (Egypt, the Sudan, and the Libyan desert) are added subsequently. The figures are in most cases given to the nearest even ten, and those not given by Prof. Supan are in brackets.

TABLE OF AREAS.

	Square miles.	
British Somaliland	59,770	
Sokotra	1,360	
British East Africa Protectorate—		
(*a*) Administered by Great Britain	139,000	
(*b*) Sphere of influence	(180,000)	
Uganda Protectorate	85,840	
Zanzibar Protectorate	965	
Gambia	3,700	
Sierra Leone	26,880	
Gold Coast	78,430	
Nigeria (with Lagos)	360,540	
South Africa	1,188,800	
East African Islands	965	
West African Islands	125	
Total British	(2,126,375)	
Egypt	247,550	
Anglo-Egyptian Sudan	784,700	
Libyan Desert	515,550	
Total under British influence ...		(3,674,175)
French Somali Coast	8,100	
Tunis	64,560	
Algeria	343,180	
French Sahara	1,942,420	
French West Africa	669,940	
French Congo	679,430	
Madagascar, etc.	229,820	
Total French		3,937,450

* Some uncertainty seems, however, to remain as to the exact direction of the dividing line between the French Sahara and the Libyan desert, which is shown by Prof. Supan in his map as running considerably to the east of south-east, the direction mentioned in the Anglo-French declaration of 1899.

TABLE OF AREAS (*continued*).

	Square miles.	
Togo	33,620	
Kamerun	190,870	
German East Africa	364,970	
German South-West Africa	317,540	
Total German		907,000
Portuguese Guinea	13,070	
Azores, Madeira, Cape Verdes	2,700	
São Thome, Principe	360	
Angola	489,790	
Mozambique	293,480	
Total Portuguese		799,400
Eritrea	42,420	
Italian Somaliland	146,530	
Total Italian		188,950
Congo State		918,810
Spanish West Africa and Islands		84,950
Tripoli		405,270
Morocco		175,830
Liberia		36,800
Abyssinia and dependencies		370,000
Lakes Chad, Tanganyika, Nyasa		33,740
Grand total		(11,532,370)

The total thus obtained for all Africa exceeds that of Prof. Supan (11,498,670 square miles) by some 33,000 square miles; the reason being that the estimates made above of the areas of British East Africa and Abyssinia exceed by this amount the area left for these in Prof. Supan's table, which certainly seems too small. But as his total for the continent is derived from an independent calculation, it is probable that the higher total should be reduced by a curtailment of the amounts given for some of the separate items. The estimate of the population of many of the territories is of course very rough, and the individual figures need not be reproduced here. The grand total obtained is 140,700,000 (or somewhat less than some recent estimates), which gives an average of 5 to the square kilometre, or 13 to the square mile.

The Swiss and African Exploration.—The part played by the Swiss in opening up Africa to geography and European culture is the subject of a recent publication of the Natural Science Society in Zürich. Switzerland has planted no colonies and established no protectorates as memorials and rewards of Swiss exploration. Stalwart henchmen as the Swiss have proved themselves in fighting the battles of other nations, Swiss travellers, too, have been content to execute the commissions, and attach themselves to the expeditions of other powers. These have, as observed by the author of this publication, appropriated the honour as well as profit of Swiss capacity for hard work. Dr. Hans Schinz, who has himself done so much for the botany and zoology of South-West Africa, has therefore by this publication discharged a patriotic service, although the ground covered is not altogether virgin soil, having been already in part broken by a lecture delivered in 1883 by Ch. Faure in Zürich, entitled "Notice sur la part des Swisses dans l'Exploration et la Civilisation de l'Afrique." The general reader will be surprised to find how many Swiss have taken part in African exploration, and how considerable the sum total of their several parts amounts to. The map at the end shows in red colour five different areas of Africa which are the immediate conquest of Swiss explorers. And, outside these more immediate domains, African

geography has cause to thank Swiss perseverance and doughtiness. Including missionaries, some sixty Swiss African travellers, not all of them, however, natives of Switzerland, though all at least virtually Swiss, pass in review—and, in consideration of the early death that overtook so many of them, not without a certain air of pathos—in Dr. Schinz's pages. Each of them is briefly characterized by a summary enumeration of his geographical achievements, and a longer or shorter sketch of his life. Among the more notable names are Burckhardt, who in 1788 received his first commission from the British African Association, and opened up the Nile valley as far as Shendi: he bequeathed 350 volumes of Oriental manuscript to Cambridge University; Munzinger (1832–75), the first to make known the geography, ethnology, and languages of large tracts of Abyssinia; Gobat, Waldmeier, and Ilg, inseparably associated with the kingdom of Menelek, which is claimed as an African Switzerland; Keller, who did important work in Somaliland, but in the field of natural science rather than of geography proper; Kaiser, whose work forms a necessary supplement to Dr. Schöller's achievements in Equatorial East Africa; and (to go back to earlier times) Braun (1580–1668), whose book on the region about Kamerun was published at Basel in 1624, and who, though claimed by Georg Henning as the "first German scientific traveller in Africa," was a native of Basel.

AMERICA.

The Mont Pelé Obelisk.—Various suggestions continue to be made for the purpose of accounting for the unusual phenomenon observed in the case of Mont Pelé, where a column of lava, estimated as having had from first to last a total height of 3000 feet, has been extruded in a solid form. On the one hand, the suggestion was made some time ago by Dr. Lane, and lately repeated unconsciously by Prof. G. K. Gilbert (*Science*, June 17, 1904), that the rapid cooling and solidification of the molten magma is occasioned by the loss of heat resulting from the escape of the contained gases, which, in passing from a state of absorption to the free condition, become greatly expanded, thus consuming the energy furnished by the heat of the magma. For the production of the Pelé spine or obelisk, what would be needed would be the arrest of the exclusion and expansion of the gas at the precise stage necessary for the solidification of the magma, the stage in which the solid matter is blown into fragments being thus not reached. On the other hand, the view is held by Prof. Heilprin (*Science*, May 20, 1904), "that the tower was merely the ancient core of the volcano that had been loosened from its moorings and lifted bodily outward by the force of the volcano's activity." Such a phenomenon, Prof. Heilprin points out, is not entirely unknown, for the structures observed by Abich in the Palandokan volcano in Transcaucasia, and by Scrope in the Puy Chopine of Auvergne, seem to have been due to a similar uplift.

British Annexation in the West Indies.—On August 15 last it was announced that Aves island—a small low island rising from ocean depths in about 13° 38′ N., 63° 36′ W.—had been annexed to the British Empire by H.M.S. *Tribune*. The island is rarely visited and but little known, but some details respecting it were given by Admiral de Horsey and another correspondent in the *Times* of August 16. It rises only about 12 to 14 feet above the sea, and is not noticeable even by day until closely approached, so that it forms a considerable danger to navigation. Its total length is only about ¾ of a mile. In 1857 a dispute arose between Great Britain and Venezuela as to the ownership of the island, which contained guano deposits of some value, though of small extent. They seem, however, to have been largely removed by American vessels. There is an anchorage in 6 fathoms on the south-west side, but a heavy cross-swell sets in from both ends. The reason for the annexation has not yet transpired.

AUSTRALASIA AND PACIFIC ISLANDS.

Marcus Island, North Pacific.—This island, one of the minute points of land in the wide expanse of the North Pacific, the exact position and even the separate existence of which has till lately been matter of some uncertainty, has within the past few years come into notice owing to the enterprise of an American guano company, and the question of ownership raised between Japan and the United States as a result of the company's operations, and finally decided in favour of the latter. In 1902, on the occasion of a voyage to the island by one of the company's ships, the offer was made to the Trustees of the Bishop Museum, in Honolulu, to send a scientific observer to investigate the geology, zoology, and botany of this hitherto unexplored spot, and, this being accepted, Mr. W. A. Bryan paid a visit to the island, scientific data regarding which were thus for the first time obtained. They are published in the *Occasional Papers* of the Museum, vol. ii. No. 1 (1903). Owing to unforeseen complications, the stay at the island was much shorter than had been planned, but the week spent in its examination permitted a general idea to be gained of its geographical history and surface features. The centre of the island lies in 24° 14′ N., 154° E., the nearest American soil being Guam, some 1000 miles distant to the south-west. Obscurity seems to prevail regarding the first discovery and naming of the island, and it has frequently been confused with other reported rocks or islets in this part of the Pacific, though its position was ascertained during the voyage of the *Tuscarora* in 1874. It is still uncertain what other points of land exist in its neighbourhood, and from the flight of birds, Mr. Bryan was led to believe that an island will be found some 50 to 75 miles to the north-east of Marcus. The island is roughly triangular in shape, its longest side measuring less than 2 miles. The highest points occur near the angles, the elevation reaching its maximum of 75 feet near the north end. The reef is of the usual fringing type, and though its outer face is jagged and broken, there seem to be only two distinct passages through it. Outside a bottom of solid rock was found on all sides at a depth of 8 to 14 fathoms within a few hundred yards of land. The coasts are formed of coral sand and shingle, with huge blocks of coral rock in parts at a considerable elevation above the sea. A very compact old beach conglomerate was also observed. The surface consists in part of similar materials, in part of sand more or less mixed with humus, and is generally thickly wooded. There are several small depressions, which are evidently remains of an original lagoon, round which the island has been built up. That it is an ancient atoll since elevated above the sea is indicated also by a striking series of steps or bench-like beaches on the eastern side; by the elevated tables of coral rock exposed; and by the huge blocks of coral rock scattered over the surface. The island has been built up also by the action of storms. Soundings in an east-and-west direction show that the island may be regarded as the summit of an elevation of the ocean's floor, due probably to volcanic disturbances, on which the reef-building corals have found a lodgment. It was hoped that an examination of the birds might bring out some interesting distributional features, but this was not the case. Certain sea and shore birds were abundant, but any terrestrial or arboreal birds that might have been accidentally introduced would have perished for want of suitable food. The present political relation with the American Continent is matched by a similar natural relation, shown by the presence of a great log, squared at the ends, which must have been transported by currents from its original home at Puget sound.

POLAR REGIONS.

The National Antarctic Expedition.—Both the *Discovery* and the *Morning* touched at the Falkland islands in the latter part of July, and may be expected to arrive in England about the second week of September. The *Terra Nova* has arrived in England.

Configuration of the North Polar Area.—A tendency has lately made itself felt in some quarters to question the validity of the conclusion, formed as a result of Nansen's voyage, that the north polar area is occupied throughout—beyond the limits of the land surfaces so far known—by an ocean of considerable depth. In commenting on the results of Peary's latest expedition, Prof. Heilprin has expressed the view that it is at least premature to conclude that no further land-masses exist in the ocean north of Greenland, and that certain facts seem rather to point in an opposite direction. A similar view of the possible existence of a large area of land in the unexplored arctic region has been expressed by Mr. R. A. Harris, of the U.S. Coast and Geodetic Survey, who bases his conclusions principally on the currents and tides of the Arctic seas. From the neighbourhood of Bering strait to that of Greenland two main currents are known to flow across the Arctic ocean, the one passing north of Alaska in an easterly direction and on through the Arctic archipelago to Davis and Hudson straits; the other starting north-westwards (as shown by the drift of the *Jeannette*) to the neighbourhood of Bennett island, there bending to the right along the line of the *Fram's* track, and eventually passing into the Greenland sea. That the *Jeannette* did not take a direct northerly route is held to point to the existence of land in that direction, possibly forming a strait in the neighbourhood of Bennett island, which would account for the increased rate of the current in this locality. Again, that land probably extends to the north of Beaufort sea (north of the Mackenzie mouth) is held to be indicated by the great age of the ice in this sea, which would seem to have no broad outlet enabling the ice to escape as it does north of Siberia. The facts so far known in respect of the tides point in the same direction. Off Point Barrow the flood comes from the west, and the semi-diurnal range, which averages only 0·4 foot, is very much less than that observed at Bennett island (2 feet). If there were no land in the neighbourhood of the pole, the tide, which comes almost entirely from the Atlantic through the Greenland sea, would reach the one point as easily as the other, and there would be no reason for this discrepancy. In the Arctic archipelago, too, there are indications that the access of the tide from the north is not altogether unrestricted. Mr. Harris gives a sketch-map showing the outline of the northern land as he supposes it to exist. It is placed mainly on the American side of the pole, and its area approaches that of Greenland, two of its sides being roughly parallel to the drift of the *Fram* and *Jeannette* respectively, while a southward prolongation is supposed to closely approach Banks Land, thus accounting for the failure of the ice in the Beaufort sea to find an egress eastwards. The paper concludes with a reference to surmises that have been made by voyagers of the existence of land in the unknown northern area, and to the report of the sighting of land north of Alaska by Captain Keenan in the seventies.

Ice in the Arctic Seas in 1903.—The annual of the Danish Meteorological Institute for 1903 gives charts showing the state of the ice in the Arctic seas throughout the months from April to August inclusive, 1903. The data concern chiefly the seas to the north of Europe, round the coast of Greenland and the north-east coasts of North America, and the Bering straits. The report, in summary, shows a normal drift of polar ice into the temperate seas, but an unusual number of icebergs carried by the Labrador current. In Barents sea only the waters round Bear island were free of ice throughout the summer. The passage

north of Novaya Zemlya and the approach to Franz Josef Land and north-east Spitzbergen were blocked most of the summer. To the end of August polar ice was met between South cape and Horne sound. During the last days of August sailing vessels had no difficulty in navigating north of Seven islands, and thence all along the north-west and west coast of Spitzbergen there was open water throughout September. Along the east coast of Greenland the winter ice lay unbroken during the first half of August. The coasts of Iceland were free of ice throughout the year, save only for a short period in April and June in Skagastrand bay. Throughout the spring and summer of 1903 there was a heavier drift of icebergs than had been known for years before along the coasts of Labrador and Newfoundland, and as late as November an iceberg was seen at Newfoundland bank. An isolated floe was observed in August at 37¾° N. and 71½° W. In Hudson strait icebergs were rather numerous, and floes somewhat more numerous than usual till the beginning of August. In Bering sea the eastern and the western passages both became available in the beginning of June, the strait being reached by both routes about June 20. The northward drift of ice in the strait ceased in the first half of July.

GENERAL.

The Population of the Earth.—In the latest issue of "Die Bevölkerung der Erde" (*Pet. Mitt.*, Ergänzungsheft 146) Prof. Supan completes his survey of the population of the world about the beginning of the twentieth century by summarizing the results of recent censuses in Europe and Australia, afterwards giving a general table showing his estimate of the population of each of the continents, and of the aggregate for the whole world. The results are as follows:—

	Total population.	Per sq. mile.
Europe	392,264,000	104
Asia	819,556,000	46·6
Africa	140,700,000	13
Australia and Polynesia	6,483,000	2
North America	105,714,000	13
South America	38,482,000	5
Polar Lands	91,000	—
Total	1,503,300,000	26

CORRESPONDENCE.

Himalayan Nomenclature.

Some months ago I was able to report to your readers that His Excellency the Viceroy of India, acting on a suggestion I had ventured, had succeeded in obtaining permission from the Nepalese Government for an English survey officer to proceed to Katmandu in order to identify the peaks visible from the heights in the neighbourhood of that city, and, further, to ascertain what names, if any, were given to them respectively by the natives of Central Nepal. The particular objects of this inquiry were to discover whether (1) Peak XV. of the Survey, the highest

measured mountain in the world, was visible from this quarter; (2) if visible, whether it had been accurately identified by the German travellers Dr. Schlagintweit and Dr. Boeck; and (3) to what summit or summits, if any, the name Gaurisankar was locally attached.

For the past controversy on these matters I must refer your readers to the list below.*

The results of the present inquiry have been as follows.† Peak XV. has been successfully identified and measured by Captain Wood from two heights near Katmandu. The late Surveyor-General, General Walker, and Colonel Waddell were therefore in error in maintaining that from this quarter it was not visible. The peak was seen, as I had predicted it would be, as a comparatively inconspicuous object over a gap in the nearer mountains.‡ The inquiry has further proved that both H. Schlagintweit and Dr. Boeck were wrong in their identification of it. (Schlagintweit's XV. is really XX., Boeck's is XXIV., of the Survey.) I was wrong, therefore, in surmising that Boeck's XV. might be identified with XVIII., and in the consequent suggestion I made with respect to the position of Peak XV. in the panorama.

With regard to nomenclature, I must quote Captain Wood textually. "As regards the naming of the various peaks, I could discover nothing. The name Gaurisankar appears to be one given (by the nobles at Katmandu only) to the two highest peaks of the group which is the only conspicuous one seen from the city (the one marked as Gaurisankar on Schlagintweit's panorama is Peak XX.), and I very much doubt if they could recognize it if seen from a slightly different point of view. At least the officer His Excellency Maharaja Chandra Shamsher sent up to Kaulia to point out this peak to me failed to recognize it, and said it was not visible from there; and even after I had pointed out the peak to him, he said it was not Gaurisankar, but a peak something like it. Every lower-class native of the valley I asked did not know the peak by that or any other name, nor did they appear to give names to any of the snows at all. At Kaulia and at Mahadeo Pokra I had several —about ten in all—hillmen brought to me who were supposed to know the names of the hills, and every one, without exception, gave different names to the same peaks, and none called the peak known in the valley as Gaurisankar by that name. Very nearly every other peak visible was pointed out as Gaurisankar when asked; but with the exception of two men, both at Kaulia, none gave the name Gaurisankar to any peak until they were asked which was Gaurisankar. My method of questioning was to lay a straight stick on the plane-table, and tell them to point it in succession to the hills whose names they knew. At first I took down the names they gave; but as each gave a different one, I did not think any reliance

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* *Alpine Journal*, vol. xii. p. 438; vol. xxi. pp. 33, 317; vol. xxii. p. 56.
Proceedings of R.G.S. (N.S.), vol. viii. pp. 88, 177, 257; xiii. p. 108.
Geographical Journal, vol. xxi. p. 294; xxiii. p. 89.
Petermanns Mitteilungen, vol. xxxiv. pt. 2; vol. xlvii. pt. 1, pt. 12; vol. xlviii. pt. 1.
'A Few Lines on Mount Everest.' By Colonel H. C. B Tanner. Calcutta: 1890.
'Round Kangchenjunga,' p. 199, and Appendix. By Douglas W. Freshfield.
'Among the Himalayas,' by L. A. Waddell, p. 345.
'Durch Indien in Verschlossenen Land Nepal,' Dr. K. Boeck, p. 314.

† 'Report on the Identification and Nomenclature of the Himalayan Peaks as seen from Katmandu, Nepal.' By Captain H. Wood, R.E. With Preface by Colonel St. G. Gore, C.S.I., R.E. Calcutta: 1904. 3*s*.

‡ *Geographical Journal*, vol. xxiii. p. 89: "It will probably be found that the great peak, if visible at all, is far from conspicuous, and only recognizable—like the Finsteraarhorn from Grindelwald"—I had better have written from Milan—"to those who know where to look for it."

could be put in them, and discontinued doing so. The two men mentioned above gave the name Gaurisankar, one to Peak XXIV. and the other to Peak XXVIII. Peak XXIV. is undoubtedly the one reproduced in the March *Journal* of the R.G.S. of 1903 from Dr. Boeck's work, and identified by Mr. Freshfield as Peak XVIII."

With this statement before my eyes, I can only express my amazement that the late Surveyor-General, Colonel Gore, should have commented on it in the following terms: "The whole evidence collected by Captain Wood is quite against the theory that Gaurisankar is a name given to the mountain mass of which Peak XX., which is the prominent point, is only one peak." As I read it, what Captain Wood's evidence proves is that the "nobles of Katmandu" call the snow summits they can see from the capital indifferently Gaurisankar, and that the hill-men are, when asked, ready to give that name to any peak visible.

Colonel Gore goes on, "There now remains the further question whether Peak XV. (Everest) can be called a peak of the group of which Peak XX. (Gaurisankar) is the most conspicuous as seen from Katmandu or its neighbourhood." "Everest," he writes, "which with Peak XIII. (Makalu) forms a separate group, stands 36 miles to the east of Peak XX., but separated from it by the upper end of the Dudh Kosi valley. The two groups are joined by a ridge running round to the north, over which the road passes by the Pangu-a" (la?) "from the Dudh Kosi valley to Dingri; but to call these groups one and the same is to my mind quite untenable." Captain Wood is, on this point, even more emphatic. "Everest . . . standing as it does quite apart from and a long way behind the main range, to call it a peak of the Gaurisankar group is absurd."

Colonel Gore has omitted to state that the so-called "road" in question is a glacier pass of over 20,000 feet, described by the Pundit who crossed it as one of great difficulty. It is, therefore, according to the principles used hitherto in the definition of Alpine groups, no proper boundary for a group. Nor, with all due deference to Captain Wood, can I see anything absurd in giving to a Himalayan group an extension only equal to that of the Bernese Oberland from the Gemmi to the Grimsel.

But I desire to be perfectly fair, and I most readily admit that to take a name which is often loosely applied, but which when specifically applied appears, as a rule, to be given to a knot, or one of a knot, of summits at one end of a group, and to fasten it on a peak 36 miles off at the other end of the group, seems at first sight a strong proceeding. Still, had the surveyors done this, they would have had the precedent of the early map-makers of Savoy, who, until nearer approach revealed the name of Mont Blanc, were content to use the generic term 'la montagne maudite,' which was often affixed by the Genevese to the Buet, for all the snows south and north of the Chamonix valley. If they did not feel justified in doing this, the surveyors might surely have waited. To call the highest mountain in the world after one of its late chiefs may seem natural to a Department, but it will hardly persuade—it has not succeeded in persuading—the world to share its view.

The question, which from the first was one mainly of taste, has in India now become partly one of feeling. It is a question on which people are likely to hold, and are justified in maintaining, different opinions. But the circumstances have changed since 1856—and even since 1886—and it seems to me no longer necessary to prolong the controversy, for the question has become an academical one. A local Tibetan name, Chomo-kankar, "The Lord of Snows," has been provided for Peak XV. on excellent native authority, confirmed by Colonel Waddell. By this the highest mountain, which stands on the frontier of Tibet, should in my opinion henceforth be designated by geographers.

I do not wish to lengthen this note by personal matter beyond what may be absolutely needful, but I cannot pass by without correction one or two statements in the recent Report. Colonel Gore observes that I allege the point of my argument to be "whether the 29,002-feet peak is among the snows visible from Kakani and known as Gaurisankar." He goes on, "This to my mind begs the question." If he will once more consider the matter, he will see, I am sure, that such an inquiry was a necessary preliminary to any profitable discussion of the main question, whether the name Gaurisankar could be legitimately affixed to Peak XV. That question had been shelved on the erroneous assertion made by a late Surveyor-General, and repeated by Colonel Waddell, that Peak XV. was invisible from near Katmandu.

Captain Wood on his part has imperfectly catalogued and incorrectly summarized (pp. 2, 3, near top) my contributions to the discussion; moreover, my attitude throughout is misrepresented. I have desired not to endorse, but to investigate, the identifications of the German travellers. In 'Round Kangchenjunga' I expressly said, "I am not prepared to treat (Dr. Boeck's) identification as satisfactorily established." I have never treated Schlagintweit's identification as established, and Captain Wood, when he states the contrary, on the authority of Schlagintweit's brother, Dr. E. Schlagintweit, has been misled. What I wrote in 1886 was—

"I am very ready to allow that General Walker has shown that the Schlagintweits' identification requires confirmation. Both Mr. Hodgson and the Schlagintweits may prove to be altogether wrong."

Finally, I must quote textually the following sentence of Captain Wood's: "Sir A. Waugh proposed first to the Government of India and then to the Royal Geographical Society in London to give to this peak the name of his predecessor in office, because, though he had always scrupulously adhered to the rule of assigning to every geographical object its true local or native appellation, the Survey officers had not been able to discover, nor were they likely to be able to do so, any local name, and that as it was probably the highest mountain in the world, he had decided to name it after his late chief and to show that it was the peak alone that was so named and not the range he prefixed the word 'Mont,' and not Mount." *

Once more, it seems, I must repeat what ought to be common knowledge, that neither in Latin nor in French, nor in the local usage of the Alps has Mons or Mont any significance beyond that of our English Mount, such as is here alleged. Has Captain Wood never heard of the Mont Cenis, the Mont St. Gotthard, and the Mont d'Or? I have shown elsewhere † that Sir A. Waugh's use of "Mont" was probably a slip of the pen or the printer, and was not followed by contemporary authorities.

DOUGLAS W. FRESHFIELD.

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* I leave the punctuation as in the original.

† *Petermanns Mitteilungen*, vol. xlviii.; *Alpine Journal*, vol. xxi.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are in each case written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Col. = Colonies.
Com. = Commerce.
C. R. = Comptes Rendus.
E. = Erdkunde.
G. = Geography, Géographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
Jb. = Jahrbuch.
k. u. k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. (mém.) = Memoirs, Mémoires.
Met. (mét.) = Meteorological, etc.
P. = Proceedings.
R. = Royal.
Rev. (Riv.) = Review, Revue, Rivista.
S. = Society, Société, Selskab.
Sc. = Science(s).
Sitzb. = Sitzungsbericht.
T. = Transactions.
Ts. = Tijdschrift, Tidskrift.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half-inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Alps. **Conway and McCormick.**

The Alps described by W. Martin Conway. Painted by A. D. McCormick. London: A. & C. Black, 1904. Size 9 × 6½, pp. x. and 294. *Illustrations. Price 20s. net. Presented by the Publishers.*

Sir Martin Conway's sketches are descriptive rather of types of Alpine and other mountain scenery than of individual scenes, and their instructiveness is thereby much enhanced. Peaks, passes, glaciers, Alpine pastures, are in turn dealt with, and there are chapters on "How to see Mountains," "How Mountains are made," "The Human Interest," etc. The illustrations are in Mr. McCormick's usual charming style.

Alps. **Schulz.**

Die Wandlungen des Klimas, der Flora, der Fauna und der Bevölkerung der Alpen und ihrer Umgebung vom Beginne der letzten Eiszeit bis zur jüngeren Steinzeit. Von Dr. A. Schulz. (Sonderabdruck aus der "Zeitschrift für Naturwissenschaften," Bd. 77.) Stuttgart: E. Schweizerbart, 1904. Size 9 × 6, pp. 41–70.

Alps. **Whymper.**

The Valley of Zermatt and the Matterhorn. A Guide by Edward Whymper. 8th edit. London: John Murray, 1904. Size 7½ × 5, pp. xiv. and 224. *Maps and Illustrations. Price 3s. net. Presented by the Author.*

Alps—Chamonix. **Whymper.**

Chamonix and the range of Mont Blanc. A Guide by Edward Whymper. 9th edit. London: John Murray, 1904. Size 7½ × 5, pp. xiv. and 206. *Maps and Illustrations. Price 3s. net. Presented by the Author.*

Alps—Glaciation. **Schulz.**

Das Schicksal der Alpen-Vergletscherung nach dem Höhepunkte der letzten Eiszeit. Von A. Schulz. (Separat-Abdruck aus dem Centralblatt für Mineralogie, Geologie und Palæontologie, 1904. S. 266–275.) Stuttgart: E. Schweizerbart, 1904. Size 9 × 6. *Presented by the Author.*

Alps—Historical. **Coolidge.**

Josias Simler et les Origines de l'Alpinisme jusqu' en 1600. Par W. A. B. Coolidge. Grenoble: [A. Gratier & J. Rey], 1904. Size 10½ × 7, pp. xxii., cxcii., 308, 328, and 100. *Map and Illustrations. Price 25 fr. Presented by the Publishers.*

Probably the most complete account yet written of the origins of Alpine climbing.

Austria—Meteorology. ———

Jahrbücher der K.K. Central-Anstalt für Meteorologie und Erdmagnetismus. Jahrgang 1902. N.F. XXXIX. Band. Wien: W. Braumüller, 1904. Size 12 × 9½, pp. xxxii., 132, 154, 32, and 24. *Presented by the K.K. Central-Anstalt für Meteorologie, etc.*

Austria-Hungary. *Jahrb. Ungar. Karpatenv.* **31** (1904): 1–17. **Hajnóci.**

Die natürlichen Verhältnisse (und der Grubenbau) des Zipser Erzgebirges. Von Dr. J. R. Hajnóci. (Erster Artikel.)

Austria-Hungary—Transylvania. *C. Rd.* **138** (1904): 1440–1442. **Martonne.**

Sur la plate-forme des hauts sommets des Alpes de Transylvanie. Note de Martonne.

Balkan Peninsula. **Baldacci.**

B.S.G. Italiana **4** (1903): 457–498, 634–645, 850–862, 930–943; **5** (1904): 141–146, 236–259, 299–315.

Nel paese del Cem. Viaggi di esplorazione nel Montenegro orientale e sulle Alpi Albanesi. Por Antonio Baldacci. *With Illustrations.*

Belgium—Flanders. *Mém. S. Belge Géologie* **18** (1904): 115–124. **Cornet.**

Sur la signification morphologique des collines des Flandres. Par J. Cornet.

Belgium—River-system. *B.S. Belge Géologie* **18** (1904): Proc.-Verb., 98–102. **Greindl.**

Quelques objections théoriques à l'hypothèse d'une superposition du réseau hydrographique de la Belgique à un réseau de failles préexistant. Par le capitaine Baron Greindl.

Færoes and Iceland. *J. Anthrop. I.* **33** (1903): 246–258. **Annandale.**

The Survival of Primitive Implements, Materials, and Methods in the Faroes and South Iceland. By Nelson Annandale. *With Plate.*

France—Brittany. *Travaux Sc. Université Rennes* **2** (1903): 333–348. **Martonne.**

Le développement des côtes bretonnes et leur étude morphologique. Par E. de Martonne.

France—Loire. *C. Rd.* **138** (1904): 1060–1062. **Welsch.**

Sur les failles et les ondulations des couches secondaires et tertiaires dans la vallée inférieure du Loire. Note de J. Welsch.

France—Map. *Ann. G.* **13** (1904): 113–120. **De la Blache.**

La carte de France au 50,000. Par P. Vidal de la Blache. *With Map.*

France—Marseilles. *B.S.G. Marseille* **27** (1903): 349–377. **Barré.**

Le Développement économique de Marseille de 1885 à 1900. Par H. Barré.

France—Montluçon. *Ann. G.* **13** (1904): 121–137. **Vacher.**

Montluçon: Essai de géographie urbaine. Par A. Vacher. *With Illustrations.*

France—Quarries. *The Quarry* **9** (1904): 265–267. ———

The Ancient Stone Quarries beneath Paris. *With Plans.*

France—Savoie. **Corcelle.**

J. Corcelle. Les Routes et les Vallées de la Savoie. Chambéry: Librairie Perrin, 1904. Size 9 × 6, pp. 122. *Illustrations. Presented by the Author.*

France—Vendée. *Rev. G.* **28** (1904): 211–216. **Pawlowski.**

Le bocage vendéen; Mervent. Par A. Pawlowski. *With Illustrations.*

Germany. *Forsch. deutsch. Landes- u. Volkskunde* **15** (1904): 296–346. **Wagner.**

Orometrie des Ostfälischen Hügellandes links der Leine. Von Dr. H. Wagner. *With Map.*

Germany—Canal. **Rose.**

Projected Rhine-Neckar-Danube Ship Canal. Foreign Office, Miscellaneous, No. 613, 1904. Size 10 × 6½, pp. 14. *Map. Price* 3*d.*

See note in the Monthly Record (p. 345).

Germany—Odenwald. **Jaeger.**

Forschungen deutsch. Landes- u. Volkskunde **15** (1904): 237–289.

Ueber Oberflächengestaltung im Odenwald. Von Dr. Fritz Jaeger. *Map.*

Iceland. *Globus* **85** (1904): 258–260. **Lehmann-Filhés.**

Die Waldfrage in Island. Von M. Lehmann-Filhés. *With Illustration.*

On the possibility of extending the growth of trees in Iceland (see *ante*, p. 346).

Italy—Sicily. **Jackson.**

Sicily. By F. H. Jackson. London: Methuen & Co., 1904. Size 6½ × 4, pp. xii. and 254. *Maps and Illustrations. Price* 3*s. Presented by the Publishers.*

Lake of Geneva. **Forel.**

F. A. Forel. Le Léman: Monographie limnologique. Tome Troisième. Deuxième livraison. Lausanne: F. Rouge & Cie, 1904. Size 10 × 6½, pp. 409-716. *Maps and Illustrations.*

This, the concluding section of M. Forel's great work, treats of the historical and economic relations of the lake.

Sweden—Frozen Soil. *Ymer* **24** (1904): 87-93. **Hamberg.**

Till frågan om förekomsten af alltid frusen mark i Sverige. Af Axel Hamberg.

Discusses the question of the existence of permanently frozen soil in Sweden.

Sweden—Upsala University. ——

Handlingar angående lediga E. O. Professors embetet i Geografi vid Upsala Universitet. Upsala, 1904. Size 8½ × 5½, pp. 128.

On the proceedings for the election of a professor of geography at Upsala University, resulting in the recommendation of Dr. Ahlenius for the post.

Switzerland—Communications. *Quest. Diplom. et Colon.* 7 (1903): 538-544. **Loiseau.**

Le Percement des Alpes Bernoises. Trusts et Concurrence Internationale.

United Kingdom. **Hull.**

On the Age of the last Uprise of the British Isles. By Prof. Edward Hull. Being a paper read before the Victoria Institute. Size 8½ × 5½, pp. 22. *Map. Presented by the Author.*

United Kingdom—England. **Woolacott.**

The Geological History of the Tyne, Wear, and Associated Streams. By D. Woolacott. (Excerpt from *Proc. Durham Philosophical Soc.*, vol. ii. pt. 3.) Newcastle-upon-Tyne: A. Reid & Co., 1903. *Presented by the Author.*

United Kingdom—Ireland. **[Murray.]**

[Murray's] Handbook for Travellers in Ireland. Sixth edition, revised and edited by John Cooke. London: E. Stanford, 1902. With Index and Directory for 1904. Size 7 × 5, pp. x., 46, and 558. *Maps and Plans. Price* 9*s. Presented by the Publisher.*

United Kingdom—Isle of Wight. **Clinch.**

The Isle of Wight. By G. Clinch. Illustrated by F. D. Bedford. London: Methuen & Co., 1904. Size 6½ × 4, pp. xii. and 184. *Maps and Illustrations. Price* 3*s. Presented by the Publishers.*

United Kingdom—London. *Scottish G. Mag.* **20** (1904): 196-202. **Richardson.**

The Port of London. (A French View.) By Ralph Richardson. *With Maps.*

United Kingdom—Scotland. **Geddes.**

A Study in City Development. Park, Gardens, and Culture-Institutes. A Report to the Carnegie Dunfermline Trust. By Patrick Geddes. Dunfermline, 1904. Size 11½ × 8½, pp. 228. *Plans and Illustrations. Presented by the Author.* [To be reviewed.]

United Kingdom—Scotland. **[Murray.]**

[Murray's] Handbook for Travellers in Scotland. Edited by Scott Moncrieff Penney. Eighth edition. London: E. Stanford, 1903. Size 7½ × 5, pp. liv. and 510. *Maps and Plans. Price* 10*s.* 6*d. Presented by the Publisher.*

United Kingdom—Scotland—Place-names. **Mackinlay.**

Influence of the Pre-Reformation Church on Scottish Place-names. By J. M. Mackinlay. Edinburgh and London: W. Blackwood & Sons, 1904. Size 9 × 6, pp. xx. and 464. *Price* 12*s.* 6*d.*

United Kingdom—Wales. **Baddeley and Ward.**

Thorough Guide Series, North Wales (Part ii.). Llangollen, Bala, Dolgelley, Barmouth, Oswestry, Shrewsbury, Welshpool, Llanidloes, Machynlleth, and Aberystwyth Sections. By J. B. Baddeley and C. S. Ward. Sixth Edition. London: Dulau & Co., 1904. Size 6½ × 4½, pp. xvi. and 158. *Maps, Plans, and Panorama. Price* 2*s.* 6*d. net. Presented by the Publishers.*

The principal improvement in this edition is the provision, as in others of the series, of coloured contoured section-maps.

United Kingdom—Woodlands. *J. R. Agric. S.* **64** (1903): 16-49. **Curtis.**

The Management and Planting of British Woodlands. By Charles E. Curtis.

United Kingdom—Yorkshire. **Fox-Strangways.**

Memoirs of the Geological Survey. England and Wales. The Geology of the Oolitic and Cretaceous Rocks south of Scarborough. (Explanation of Sheets 54 and 55, New Series; 95 S.E. and 95 S.W., Old Series.) By C. Fox-Strangways. Second Edition. London: E. Stanford, 1904. Size 10 × 6½, pp. viii. and 120. *Map and Illustrations. Price* 4*s.* 6*d. Presented by the Director of the Geological Survey and Museum.*

United Kingdom—Yorkshire. **Morris.**

The North Riding of Yorkshire. By J. E. Morris. Illustrated by R. J. S. Bertram. London: Methuen & Co., 1904. Size 6½ × 4, pp. xiv. and 432. *Maps and Illustrations. Price* 3*s. Presented by the Publishers.*

ASIA.

Arabia. *C. Rd.* **138** (1904): 1445-1447. **Houdas.**

Sur une éruption volcanique qui a eu lieu en Arabie, près de la ville de Médine, le 30 juin 1256. Note de M. Houdas.

Asia. *Popular Sci. Monthly* **65** (1904): 68-73. **Kropotkin.**

The Geology and Geo-botany of Asia. By Prince P. Kropotkin.

Caspian Sea. *Petermanns M.* **50** (1904): 126-128. **Knipowitsch.**

Hydrobiologische Untersuchungen des Kaspischen Meeres. Reiseberichte von N. Knipowitsch.

Central Asia—Tian Shan. *Appalachia* **10** (1904): 277-284. **Davis.**

A Flat-topped Range in the Tian-Shan. By W. M. Davis.

Ceylon. **Ferguson.**

Ceylon in 1903, describing the Progress of the Island since 1803, its present Agricultural and Commercial Enterprises, and its unequalled Attractions to Visitors. By John Ferguson, C.M.G. Colombo: A. M. & J. Ferguson, 1903. Size 8 × 5¼, pp. viii., 40, 154, and clxxxvi. *Map and Illustrations. Presented by the Author.*

China. *Petermanns M.* **50** (1904): 131-140. **Anz.**

Eine Winterreise durch Schantung und das nördliche Kiang-su. Von W. Anz. *With Map.*

China. *Contemporary Rev.* **85** (1904): 871-877. **Boulger.**

The Shanghai-Nanking Railway. By D. C. Boulger.

China. *La G., B.S.G. Paris* **9** (1904): 493-495. **Lemoine.**

Voyage au Yun-nan et aux régions tibétaines. But de voyage, par M. le lieutenant Grillières. *With Map.*

Lieut. Grillières did some survey work in the region of the upper Yangtse, Mekong, and Salwen.

China. *Asien* **3** (1904): 55-59. **Pflughöft.**

Tsinanfu, die Hauptstadt von Schantung. Von H. Pflughöft. *With Plan.*

China. *La G., B.S.G. Paris* **9** (1904): 461-464. **Servagnat and Aïtoff.**

Les déplacements du Houn-Ho inférieur. Par D. Aïtoff. *With Map.*

Based on a study by Lieut. Servagnat in the *Revue des Troupes Coloniales.*

China. ——

Commercial China in 1904. Area, Population, Production, Railways, Telegraphs, and Transportation Routes, and Foreign Commerce and Commerce of United States with China. [From the *Monthly Summary of Commerce and Finance* for January, 1904.] Washington, 1904. Size 12 × 9½, pp. 2325-2446. *Map.*

China—Mongolia. **Kidston.**

China, No. 3 (1904). Despatch from His Majesty's Minister at Peking, enclosing a Report by Mr. George J. Kidston on a Journey in Mongolia. London: Eyre & Spottiswoode, 1904. Size 13 × 8½, pp. 26. *Map and Illustrations. Price* 6*d.*

The route lay almost entirely to the west of Mr. Campbell's.

China—Trade. ——

China. Imperial Maritime Customs. 1.—Statistical Series: Nos. 3 and 4. Returns

of Trade and Trade Reports for the year 1903. Part i. Report on the Trade of China, and Abstract of Statistics. Shanghai: Kelly & Walsh; London: P. S. King & Son. 1904. Size 11 × 9, pp. 40.

China—Treaties.

Treaties between the Empire of China and Foreign Powers, together with regulations for the Conduct of Foreign Trade, Conventions, Agreements, Regulations, etc., etc., the Peace Protocol of 1901, and the Commercial Treaty of 1902. Fourth Edition. Shanghai: *North-China Herald* Office, 1902. Size 9½ × 6½, pp. 332.

China Sea—Sailing Directions.

The China Sea Directory, vol. iii., or Sailing Directions for the Coast of China from Hongkong and the Chu Kiang to the Yalu Kiang. Fourth Edition. London: J. D. Potter, 1904. Size 9½ × 6, pp. xxviii. and 716. *Index, Map, and Diagrams. Price* 4*s.* 6*d. Presented by the Admiralty.*

Chinese Empire—Mongolia. *Petermanns M.*, **50** (1904): 152–153. **Woeikow.**

Peretoltschines Erforschung des Kossogol-Sees. Von Prof. Dr. A. Woeikow.

Chinese Empire—Tibet. **Grenard.**

Mission Dutreuil de Rhins dans la Haute Asie. Le Tibet, le pays et les habitants. Par F. Grenard. Paris: A Colin, 1904. Size 7½ × 5, pp. iv. and 388. *Map. Price* 5*fr. Presented by the Publisher.*

A useful general account of Tibet and its inhabitants, with a sketch of the history of travel within its borders.

Chinese Turkestan. **Stein.**

Sand-buried Ruins of Khotan. Personal Narrative of a Journey of Archæological and Geographical Exploration in Chinese Turkestan. By M. Aurel Stein. Cheaper Edition. London: Hurst & Blackett, 1904. Size 9 × 6, pp. xl. and 504. *Maps and Illustrations. Price* 7*s.* 6*d. net. Presented by the Publishers.*

In spite of its moderate price, this new edition of Dr. Stein's work (*Journal*, vol. xxii. p. 449) is excellently got up, and should find many readers.

Eastern Asia. **Hatch.**

Far Eastern Impressions. By E. F. G. Hatch, M.P., Japan, Korea, China. London: Hutchinson & Co., 1904. Size 8 × 5½, pp. xiv. and 258. *Maps and Illustrations. Price* 6*s. net. Presented by the Publishers.*

Embodies the results of studies and inquiries made during a tour some years ago, corrected by later knowledge. The book will be read with interest in connection with the present war.

Malay Archipelago—Borneo. **Nieuwenhuis.**

Quer durch Borneo. Ergebnisse seiner Reisin in den Jahren 1894, 1896–97 und 1898–1900. Von Dr. A. W. Nieuwenhuis. Unter Mitarbeit von Dr. M. Nieuwenhuis—von Uxküll-Güldenbandt. Erster Teil. Leiden: E. J. Brill, 1904. Size 11 × 8, pp. xvi. and 494. *Maps and Plates. Price* 21*s.*

To be reviewed.

Russia—Siberia—Semiretchinsk. **Sapozhnikoff.**

Iz. Imp. Russian G.S. **39** (1903): 273–294.

Preliminary Report of the Semiretchinsk Scientific Expedition. By Prof. V. V. Sapozhnikoff. [In Russian.]

Russia—Siberia—Yeneseisk. *Zap. Imp. Russian G.S., General G.* **34**, No. 2. **Kriloff.**

Notes of a Journey in the Country of the Uriankhais. By P. Kriloff. Size 10 × 6½, pp. 167. St. Petersburg, 1903. *Maps and Profiles.* [In Russian.]

The country dealt with lies south-east of Minusinsk.

Russia—Transcaucasia—Georgian Language. **Dirr.**

Theoretisch-praktische Grammatik der modernen georgischen (grusinischen) Sprache, mit Uebungsstücken, einem Lesebuch, einer Schrifttafel und einer Karte. Von A. Dirr. Wien und Leipzig: A. Hartleben, [*not dated*]. Size 7 × 4½, pp. xiv. and 170. *Price* 2 *m. Presented by the Publisher.*

Russian Central Asia—Sir Darya. **Pyzirevsky.**

Iz. Imp. Russian G.S. **38** (1902): 503–545.

The characteristics and the Navigation of the Sir Darya. By N. P. Pyzirevsky. *Map.* [In Russian.]

Tibet. *Contemporary Rev.* **85** (1904): 640–648. **Ular.**

The Solution of the Tibetan Problem. By A. Ular.

Tibet. *Mem. S.G. Italiana* **10** (1904): pp. lxiv. and 402. **Puini.**

Carlo Puini. Il Tibet (Geografia, Storia, Religione, Costumi) secondo la relazione del Viaggio del P. Ippolito Desideri (1715–1721).

This work of the well-known missionary Desideri is now printed for the first time. The author, by his lengthened stay in Lhasa, gained a fuller insight than most of the early missionaries into the religion, manners, and customs of the Tibetans, which he here describes in detail.

Tibet—Lhasa. **Kawaguchi.**

The Latest News from Lhasa. A Narrative of Personal Adventure. By the Rev. Ekai Kawaguchi. Introduction by Miss Scidmore. (From the *Century Magazine.*) Size 9½ × 7, pp. 383–393. *With Portrait.*

Tibet—Lhasa. *Globus* **85** (1904): 269–274. **Wegener.**

Lhassa. Von Dr. G. Wegener. *With Plan. Also Separate Copy, presented by the Author.*

Turkey and Persian Gulf. *National G. Mag.* **15** (1904): 139–151. **Fairchild.**

Travels in Arabia and along the Persian Gulf. By D. G. Fairchild. *With Illustrations.*

The writer was sent by the U.S. Department of Agriculture to report on agricultural possibilities in Babylonia, and to secure the best varieties of Persian and Arabian dates for cultivation in Arizona.

AFRICA.

Africa. **Dehérain.**

Henri Dehérain. Études sur l'Afrique. Soudan Oriental, Éthiopie, Afrique Équatoriale, Afrique du Sud. Paris: Hachette et Cie., 1904. Size 7½ × 5, pp. vi. and 302. *Maps. Presented by the Publishers.*

A collection of articles which have appeared in periodical publications on various subjects connected with the exploration and political conquest of Africa, on which the author is a well-known authority.

Africa. *Nineteenth Century* **55** (1904): 937–946. **Johnston.**

The White Man's place in Africa. By Sir H. H. Johnston, G.C.M.G., etc.

The writer insists that, apart from certain healthy regions capable of colonization by whites, the greater part of tropical Africa must be regarded as a black man's country, in which the interests of the black man must be rated first.

Africa. **Weinthal.**

"Round Africa" by the D.O.A. Line. A Guide Book for Passengers to North, East, and South Africa. Compiled and edited by Leo Weinthal. London: A. Andrews, [1902]. Size 6½ × 5, pp. 392. *Maps and Illustrations. Presented by the Compiler.*

Africa—Swiss Explorers. **Schinz.**

Schweizerische Afrika-Reisende und der Anteil der Schweiz an der Erschliessung und Erforschung Afrikas überhaupt. Von Prof. Dr. H. Schinz. (Neujahrsblatt herausgegeben von der Naturforschenden Gesellschaft auf das Jahr 1904. 106 Stück.) Zürich. Size 11½ × 9, pp. 52. *Map.*

British Central Africa—Bemba Language. **Robertson.**

An Introductory Handbook to the Language of the Bemba People (Awemba). By W. G. R. London: the London Missionary Society, 1904. Size 7 × 4½, pp. xxii. and 546. *Presented by the Author.*

Ivory Coast—Languages. **Delafosse.**

Vocabulaires comparatifs de plus de 60 Langues ou Dialectes parlés à la Côte d'Ivoire et dans les régions limitrophes. Avec des Notes linguistiques et ethnologiques, une Bibliographie et une Carte. Par Maurice Delafosse. Paris: E. Leroux, 1904. Size 11½ × 7½, pp. iv. and 286.

Madagascar. **Grandidier.**

Collection des Ouvrages anciens concernant Madagascar publiée sous la direction de MM. A. Grandidier, C. Roux, C. Delhorbe, H. Froidevaux et G. Grandidier. Tome ii. Ouvrages ou extraits d'ouvrages français (jusqu'à 1630), portugais, hollandais, anglais, allemands, italiens, espagnols et latins relatifs à Madagascar (1613 à 1640). Par MM. A. Grandidier et G. Grandidier. Paris: Comité de Madagascar, 1904. Size 10 × 6½, pp. 560. *Maps and Illustrations.*

To be reviewed with vol. i.

Madagascar. **Matthews.**

Thirty Years in Madagascar. By the Rev. T. T. Matthews of the London Missionary Society. London: The Religious Tract Society, 1904. Size 8¼ × 5½, pp. 384. *Map and Illustrations. Price* 6*s. Presented by the Publishers.*

An account of the progress of Protestant missions in Madagascar during the past thirty years, with a good deal of incidental reference to political and other events during that period.

Morocco. **Aubin.**

Eugène Aubin. Le Maroc d'aujourd'hui. Paris: A. Colin, 1904. Size 7½ × 5, pp. xii. and 500. *Maps and Plan. Price* 5*fr. Presented by the Publisher.*

The writer travelled in Morocco in 1902–03, and though he seems hardly to have left the beaten tracks, the evident pains which he took to make himself acquainted with the present condition of the country render the work of some interest.

Orange River Colony. *T. Geolog. S. South Africa* **6** (1904): 20–26. **Molengraaff.**

Remarks on the Vredefort Mountain-Land. By Dr. G. A. F. Molengraaff. *With Sketch-map and Section.*

Rhodesia. **Hall and Neal.**

The Ancient Ruins of Rhodesia (Monomotapæ Imperium). By R. N. Hall and W. G. Neal. Second Edition. London: Methuen & Co., 1904. Size 9 × 6, pp. xlviii. and 404. *Map, Plans, and Illustrations. Price* 10*s.* 6*d. net. Presented by the Publishers.*

In the absence of the authors in South Africa for the purpose of further research, this edition has been carefully revised by Prof. Keane.

Sahara. *Rev. G.* **28** (1904): 54–60. **Kerganof.**

Tableaux du Sahara: un Convoi au Tidikelt. Par Yves Kerganof. *Illustrations.*

South Africa. **Bryden.**

A History of South Africa from the First Settlement by the Dutch, 1652, to the Year 1903. By H. A. Bryden. London: W. Sands, 1904. Size 8 × 5, pp. viii. and 364. *Map. Presented by the Publisher.*

Though more of a compilation than a result of original research, this compact *résumé* of South African history will be useful to the general reader, for whom such detailed histories as Dr. Theal's are unsuitable.

South Africa. *T. Geolog. S. South Africa* **6** (1904): 16–19. **Corstorphine.**

Note on the Age of the Central South African Coalfield. By Dr. G. S. Corstorphine.

South Africa. *T. Geolog. S. South Africa* **6** (1904): 60–67. **Johnson.**

On the Discovery of Implement-bearing Deposits in the Neighbourhood of Johannesburg: their relative Age, and Bearing on the Question of the Antiquity of Man in South Africa. By J. P. Johnson. *With Plates.*

South Africa—Climate. *Z. Ges. Erdk. Berlin* (1904): 176–193. **Passarge.**

Die Klimatischen Verhältnisse Süd-Afrikas seit dem mittleren Mesozoicum. Von Dr. S. Passarge. *With Plates.*

South-West Africa—Frontier. *M. a. d. Deuts. Schutzgebieten* **17** (1904): 6–28. ——

Die deutsch-englische Grenzvermessung in Deutsch-Südwestafrika, 1898–1903. *Map.*

Geographische Koordinatentafel der Dreieckspunkte der deutsch-englischen Grenzvermessung.

Tunis. **Pervinquière.**

Étude géologique de la Tunisie Centrale. (Thèses présentées à la Faculté des Sciences de Paris pour obtenir le grade de Docteur ès Sciences Naturelles. Par L. Pervinquière.) Paris: F. R. de Rudeval, 1903. Size 12 × 9½, pp. 360. *Map and Illustrations.*

Victoria Nyanza. *Mouvement G.* **21** (1904): 61–64, 73–75. **Cornet.**

Le Victoria-Nyanza est-il un *Relictensee*? Par J. Cornet.

Contests the theory that the African lakes are vestiges of a Jurassic sea.

Wadai. **Nachtigal.**

Renseign. Colon., Com. l'Afr. Franc. (1903): 49–72, 104–119, 135–146, 167–173, 180–197, 215–230, 247–255, 268–276.

Le Voyage de Nachtigal au Ouadaï, traduction par J. Van Vollenhoven. *With Map.*

Translation of the portion of Nachtigal's work 'Sahara und Sudan' relating to Wadai.

West Africa. *La G., B.S.G. Paris* **9** (1904): 257–267. **Hulot.**

Historique des missions Bénoué-Tchad. Par — Hulot.

NORTH AMERICA.

Alaska. *National G. Mag.* **15** (1904): 213–219. **Brooks.**

The Geography of Alaska. By A. H. Brooks. *With Map.*

The map is on the scale of 1 : 2,500,000 (about 40 miles to the inch), and embodies the results of recent surveys.

Alaska. **Cardot and others.**

Harriman Alaska Expedition, with co-operation of Washington Academy of Sciences, Alaska. Vol. v. Cryptogamic Botany. By J. Cardot, Clara E. Cummings, Alexander W. Evans, C. H. Peck, P. A. Saccardo, De Alton Saunders, I. Thériot, and William Trelease. New York: Doubleday, Page & Co., 1904. Size 10½ × 7½, pp. 424. *Plates. Price* $5 *net. Presented by the Publishers.*

A brief introduction outlines the general character of the cryptogamic flora, but the bulk of the volume is taken up with systematic descriptions of the collections.

Alaska. **Mendenhall.**

Reconnaissance from Fort Hamlin to Kotzebue Sound, Alaska, by way of Dall, Kanuti, Allen, and Kowak Rivers. By W. C. Mendenhall. (United States Geological Survey, Professional Paper, No. 10.) Washington, 1902. Size 11½ × 9, pp. 68. *Maps and Illustrations. Presented by the U.S. Geological Survey.*

Alaska—Boundary. **Davidson.**

The Alaska Boundary. George Davidson. San Francisco: Alaska Packers Association, 1903. Size 10½ × 7, pp. 236. *Portrait and Maps. Presented by the Author.*

An elaborate presentment of the United States view in the recent boundary dispute, written before the award was made. It is based on a thorough knowledge of the whole literature of the subject, and is a valuable contribution to historical geography.

Canada. **Lynch.**

Three Years in the Klondike. By J. Lynch. London: E. Arnold, 1904. Size 9½ × 6, pp. 280. *Map and Illustrations. Price* 12*s.* 6*d. net. Presented by the Publisher.*

Gives a vivid idea of life in the gold-fields of the far North-West. There are some good photographs and sketches of Yukon scenery, etc., including a striking general view of Dawson.

North America. **Russell.**

North America. By Israel C. Russell. London, etc.: H. Frowde, 1904. Size 9½ × 6½, pp. viii. and 436. *Maps and Illustrations. Price* 7*s.* 6*d. net. Presented by the Publisher.*

To be reviewed.

CENTRAL AND SOUTH AMERICA.

Andes. *Mém. S. Belge Géologie* **18** (1904): 79–105. **Ballore.**

Les Andes méridionales sismiques. Par F. de Montessus de Ballore. *With Map.*

Argentine Republic. **Carrasco.**

El Crecimiento de la Población de la República Argentina comparado con el de las principales naciones, 1890–1903. Trabajo presentado al segundo Congreso Médico Latino-Americano de Buenos Aires. Por G. Carrasco. Buenos Aires, 1904. Size 10½ × 7, pp. 14. *Diagrams. Presented by the Oficina Demográfica Argentina.*

Argentine Republic—Buenos Aires. *Petermanns M.* **50** (1904): 83–92, 112–117. **Hauthal.**
Beiträge zur Geologie der argentinischen Provinz Buenos Aires. Von Prof. Dr. R. Hauthal. *With Map and Illustrations.*

Argentine—Historical. **Mitre and Quevedo.**
Ulrich Schmídel. Viaje al Rio de la Plata (1534–1554). Notas Bibliográficas y Biográficas por Bartolomé Mitre. Prólogo, Traducción y Anotaciones por S. A. Lafone Quevedo. Buenos Aires: Cabaut y Cia., 1903. Size 9 × 6, pp. xvi. and 500. *Maps and Illustrations. Presented by Sr. Lafone Quevedo.*
See review, *ante.*

Bolivia. **Créqui-Montfort and Sénéchal de la Grange.**
B.S.G. Économ. et Com. Paris **26** (1904): 76–84.
L'Exploration des Hauts-Plateaux boliviens. Mission de Créqui-Montfort et Sénéchal de la Grange. *With Map.*
Cf. note in Monthly Record for April, 1904 (p. 525).

Bolivia. *La G., B.S.G. Paris* **9** (1904): 409–430. **Neveu-Lemaire.**
Le Titicaca et le Poopo. Contribution à l'étude des lacs des hauts plateaux boliviens. Par Dr. M. Neveu-Lemaire. *With Map and Illustrations.*

Bolivia. ——
Sinopsis Estadistica y Geográfica de la Republica de Bolivia. Tomo iii. La Paz, 1904. Size 9 × 6, pp. 340.

Brazil—Acre. *Deutsch. Rundschau G.* **26** (1904): 354–362. ——
Aus dem Acre-Gebiet (Brasilien).

Brazil—Bahia. **Franca.**
Traffic of the State of Bahia. Justino da Silveira Franca. Bahia, 1904. Size 10½ × 8, pp. 26. *Map. Presented by Sr. A. J. de Souza Carneiro.*

Brazil—Bahia. ——
Secretaria da Agricultura, Viação, Industria e Obras Publicas do Estado da Bahia. Annexos ao Relatorio do Secretario da Agricultura, Miguel Calmon du Pin e Almeida, 1903. Bahia, 1904. Size 11 × 7½, pp. 110. *Maps. Presented by Sr. A. J. de Souza Carneiro.*
Reports on road and railway surveys.

Brazil—Stone Reefs. **Branner.**
B. Museum Comparative Zoology, Harvard College **44** (1904): pp. 286.
The Stone Reefs of Brazil, their Geological and Geographical relations, with a Chapter on the Coral Reefs. By J. C. Branner. *With Maps and Plates. Presented by Prof. A. Agassiz.* [To be reviewed.]

AUSTRALASIA AND PACIFIC ISLANDS.

Australasia—Climate. **Gregory.**
The Climate of Australasia in reference to its Control by the Southern Ocean. . . . By Prof. J. W. Gregory, D.SC. Melbourne, etc.: Whitcombe & Tombs, 1904. Size 7 × 5, pp. 96. *Diagrams. Price* 1*s.*

Australia. *Scottish G. Mag.* **20** (1904): 253–261. **Macdonald.**
The Opal Formations of Australia. By R. M. Macdonald. *With Illustrations.*

Central Australia. **Spencer and Gillen.**
The Northern Tribes of Central Australia. By B. Spencer and F. J. Gillen. London: Macmillan & Co., 1904. Size 9 × 6, pp. xxxvi. and 784. *Maps and Illustrations. Price* 21*s. net. Presented by the Publishers.*
Embodies the information collected by the well-known explorers of Central Australia relative to the social organization, ceremonies, and customs of the aborigines.

Ellice Islands—Funafuti. ——
The Atoll of Funafuti. Borings into a Coral Reef and the Results. Being the Report of the Coral Reef Committee of the Royal Society. London: Published by the Royal Society, Harrison & Sons, 1904. Size 12 × 9½. *Maps (in separate cover), Chart, and Illustrations. Presented by the Royal Society.* [See review, *ante.*]

New South Wales and Victoria. *Victorian G.J.* **20** (1902): 71–84. **Ogler.**
Original Official Boundary between New South Wales and Victoria. By S. C. H. Ogler. *Map.*

New Zealand. **Courte.**

Comte de Courte. La Nouvelle-Zélande. Préface de M. le Baron Hulot. Paris: Hachette et Cie., 1904. Size 10 × 6½, pp. 268. *Illustrations. Price* 12*fr. Presented by the Publishers.*

The author, who is (or has been) French Consul in New Zealand, gives a vivid description of the natural scenery of New Zealand, and sketches the life of the people.

Pacific. *Victorian G.J.* **21** (1903): 85–98. **Macdonald.**

Mysteries of the Pacific. By A. C. Macdonald.

Mainly concerned with Easter island and Ponape, and their early inhabitants.

Pacific—French Islands. *S.G. l'Est* **24** (1903): 114–131; 257–280. **Lemire.**

L'Océanie Française. La France dans le Pacifique. Par Ch. Lemire.

Pacific—Quiros' Discoveries. *Victorian G.J.* **21** (1903): 121–125. **Collingridge.**

Report on the Identification of Queiroz' Discoveries in the Regions of his Tierra Austrialia del Espiritu Santo. By Geo. Collingridge.

Suggests that the exact site of Quiros' anchorage in the bay of St. Philip and St. James in Santo has become silted up.

POLAR REGIONS.

Antarctic. *C. Rd.* **139** (1904): 90–91. **Arçtowski.**

Sur la variabilité de la température dans les régions Antarctiques. Note de H. Arçtowski.

Antarctic. **Arçtowski.**

Y a-t-il Moyen d'arriver au Pole Sud en automobile. Par Henryk Arçtowski. Bruxelles, 1903. Size 10 × 6½, pp. 6. *Illustrations.* (Extr. du No. 11 (1903) du B. S. belge d'Astron.) *Presented by the Author.*

The author thinks it possible that a motor vehicle might be constructed, which should take the place of the sledges hitherto used for Antarctic journeys.

Antarctic. *National G. Mag.* **15** (1904): 220–221. **Balch.**

Termination Land. The Western end of the Antarctic continent discovered by the American Wilkes. By E. S. Balch.

The writer shows that the existence of Wilkes Land is confirmed by the work of the German Antarctic Expedition.

MATHEMATICAL GEOGRAPHY.

Astronomy. **Christie.**

Astrographic Catalogue 1900·0, Greenwich Section Dec. + 64° to 90°. From Photographs taken and measured at the Royal Observatory, Greenwich, under the direction of W. H. M. Christie, C.B., etc., Astronomer Royal. Vol. i. Measures of Rectangular Co-ordinates and Diameters of Star Images, Dec. + 64° to + 72°. Edinburgh, 1904. Size 13 × 10½, pp. lxiv. and 738. *Plates. Presented by the Astronomer Royal, Greenwich.*

Determination of Position. **Gelcich.**

Die astronomische Bestimmung der geographischen Koordinaten. Von E. Gelcich. (Die Erdkunde . . . herausgegeben von M. Klar, vii. Teil.) Leipzig und Wien: F. Deuticke, 1904. Size 10½ × 7, pp. x. and 126.

Geodesy. *Sitz. K.P.A.W. Berlin* (1904): 295–300. **Albrecht.**

Neue Bestimmung des geographischen Längenunterschiedes Potsdam-Greenwich. Von Prof. Dr. T. Albrecht.

Surveying. **Larminat.**

E. de Larminat. Topographie pratique de reconnaissance et d'exploration suivie de notions élémentaires pratiques de géodésie et d'astronomie de campagne. Paris: H. Charles-Lavauzelle, [not dated]. Size 9 × 6, pp. 344 and 12. *Illustrations. Price* 6*s.* 6*d.*

Surveying. **Mockler-Ferryman.**

Military Sketching and Reconnaissance. By Lieut.-Colonel A. F. Mockler-Ferryman. London: E. Stanford, 1903. Size 7½ × 5, pp. xii. and 202. *Illustrations. Price* 5*s. net. Presented by the Publisher.*

An excellent little book, giving clear and concise directions for reconnaissance work.

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Climates. **Bertrand.**

Le Rythme des Climats. La Glaciation, la Panthermalité. Par J. Bertrand. (Extrait des Nos. 5-6 [1904] du *Bulletin de la Société belge d'Astronomie.*) Bruxelles: Société Belge d'Astronomie. Size 10 × 6½, pp. 48. *Maps and Diagrams. Presented by the Author.*

Geology—Bibliography. ——

International Catalogue of Scientific Literature. Second Annual Issue. H. Geology. London: Harrison & Sons, 1904. Size 8½ × 5½, pp. viii. and 256. *Price* 16*s.* 6*d.*

Geomorphology—Angle of slope. **Piwowar.**

Vierteljahrs. Naturforsch. Ges. Zürich **48** (1903): 335-359.

Ueber Maximalböschungen trockener Schüttkegel und Schutthalden. Von A. Piwowar.

Geomorphology—Terraces. **Popoff.**

Verh. Russ.-K. Mineralog. Gec. St. Petersburg **41** (1904): 55-64.

Zur Frage von der Entstehung terrassenähnlicher Abstufungen, an moränebedeckten Gebirgsanhängen, unter Inlandeis gewesener Gebiete. Von Boris Popoff.

Based on observations in Russian Lapland.

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Anthropogeography. *Petermanns M.* **50** (1904): 68-79, 92-95. **Friedrich.**

Wesen und geographische Verbreitung der "Raubwirtschaft." Von Dr. E. Friedrich. *Also separate copy, presented by the Author.*

Anthropology—Bibliography. ——

International Catalogue of Scientific Literature. Second Annual Issue. P. Physical Anthropology. London: Harrison & Sons, 1904. Size 8½ × 5½, pp. viii. and 300. *Price* 15*s.*

One of the most complete and comprehensive of the volumes of the International Catalogue, especially with regard to English publications.

Historical—Early Voyages. **Hakluyt.**

The Principal Navigations, Voyages, Traffiques, and Discoveries of the English Nation, etc. By Richard Hakluyt. Vols. v. and vi. Glasgow: J. MacLehose & Sons, 1904. Size 9 × 6, pp. (vol. v.) xvi. and 512; (vol. vi.) xvi. and 528. *Maps and Plates. Presented by the Publishers.*

The whole of these two volumes deal with voyages to the south and south-east. Like the former volumes, their value is enhanced by reproductions of early maps, plans, and portraits, among the most interesting being illustrations of ships of the period, from the 'Architectura Navalis' of J. Furttenbach; a sailing chart of the Mediterranean made by Jacobus Russus, of Messina, in 1564; an English sailing chart by T. Wood, of date 1592; the despatch from Sir F. Drake describing the burning of the Spanish ship in Cadiz Harbour, 1587; and William Borough's chart of the same operations.

Historical—Levant Company. **Rosedale.**

Queen Elizabeth and the Levant Company. A Diplomatic and Literary Episode of the Establishment of our Trade with Turkey. Edited with Twenty-six Facsimile Illustrations of Manuscripts and other Interesting Plates, from Manuscripts in His Majesty's Public Record Office, the Manuscript Department of the British Museum, and the Archives of Venice, etc. By the Rev. H. G. Rosedale, D.D. London: H. Frowde, 1904. Size 13½ × 9½, pp. xii. and 92. *Price* 10*s.* 6*d. net. Presented by the Royal Society of Literature.* [See review, *ante.*]

BIOGRAPHY.

Duchesne-Fournet. *Questions Dipl. et Colon.* **17** (1904): 822-827. **Lemoine.**

Jean Duchesne-Fournet. Par F. Lemoine.

This promising young French explorer (*Journal*, xxii. 213) died early in the present year.

Fea. **Gestro.**

Leonardo Fea ed i suoi viaggi. Cenni biografici di R. Gestro. Genova, 1904. Size 10 × 7, pp. 60. *Portrait and Maps. Presented by the Author.*

Fea was known principally as an enthusiastic zoological collector in Burma, West Africa, etc. He was also an expert engraver on wood.

GENERAL.

Bibliography. **Baschin.**

Bibliotheca Geographica, herausgegeben von der Gesellschaft für Erdkunde zu Berlin. Bearbeitet von Otto Baschin. Band ix. Jahrgang 1900. Berlin: W. H. Kühl, 1903. Size 9½ × 6, pp. xvi. and 510. *Presented by the Gesellschaft für Erdkunde, Berlin.*

Geography. **Mill.**

An Elementary Class-Book of General Geography. By H. R. Mill, D.SC., LL.D. London: Macmillan & Co., 1904. Size 7½ × 5, pp. xiv. and 382. *Illustrations. Price* 3*s.* 6*d. Presented by the Publishers.*

In this edition the book has once more been thoroughly revised, recent political changes and colonial developments being noted, and population statistics brought up to date.

NEW MAPS.

By E. A. REEVES, *Map Curator*, R.G.S.

EUROPE.

Central Europe. **Liebenow and Ravenstein.**

Liebenow-Ravenstein's Special-Radfahrerkarte von Mittel-Europe. Scale 1 : 300,000 or 4·7 stat. miles to an inch. Sheets: 69, Hertogenbosch; 82, Brüssel; 83, Maastricht; 96, Valenciennes; 97, Givet; 109, Beauvais; 110, Reims; 111, Verdun; 120, Trentschin; 123, Paris; 124, Châlons-sur-Marne; 125, Bar le Duc; 131, Budweis; 132, Znaim; 133, Lundenburg; 139, Langres; 145, Linz; 146, St. Polten; 147, Wien; 153, Dijon; 154, Basel; 155, Zürich; 156, Bregenz; 157, Innsbruck. Frankfurt-a.-M.: Ludwig Ravenstein, [1904].

England and Wales. **Bartholomew.**

The Survey Atlas of England and Wales. A series of eighty-four plates of maps and plans, with Descriptive Text, illustrating the Topography, Physiography, Geology, Climate, and the Political and Commercial Features of the Country. Designed by and prepared under the direction of J. G. Bartholomew, F.R.S.E., F.R.G.S. Parts xvii. and xviii. Edinburgh: John Bartholomew & Co., 1903. *Price* 2*s* 6*d. each part. Presented by the Publishers.*

These parts contain plates 28, 34–37, 40–42, forming the following sections of the 2-mile-to-the-inch general map of England and Wales: xvii. (Chester and Manchester); xviii. (Newark and Grantham); xxiv. (Derby and Nottingham); xxv. (Crewe and the Potteries); xxvi. (Bala and Wrexham); xxix. (Montgomery); xxx. (Wolverhampton); xxxi. (Birmingham and Rugby).

England and Wales. **Ordnance Survey.**

ORDNANCE SURVEY OF ENGLAND AND WALES:—Sheets published by the Director-General of the Ordnance Survey, Southampton, from July 1 to 31, 1904.

2 miles to 1 inch:—

Printed in colours, New Forest and surrounding country, parts of sheets 78, 79, 86, 87, 95, 96, 1*s.* 6*d.*; Monmouth, sheet 69, 1*s.*

1 inch:—

Printed in colours, 254, 1*s.* (third edition).
District map, with roads in colour, New Forest: encased, on paper, 1*s.*, or mounted on linen, 1*s.* 6*d.* (third edition).
(Third edition) in outline, 218, 1*s.* (engraved).
(Third edition) with hills in brown or black, 218, 268, 285, 1*s. each* (engraved).

6-inch—County Maps (first revision):—

Brecknockshire, 5 S.E. **Gloucestershire,** 71 N.W., N.E., 72 S.E. **Herefordshire,** 8 N.W., 11 S.W., 12 S.E., 18 N.E., S.E. **Leicestershire,** 19 N.W., S.E., 22 N.E., 24 S.E., 31 S.E.,

38 S.E. **Radnorshire**, 22 S.E. **Shropshire** (80 S.W., S.E.), 83 N.W., N.E., 84 N.W. **Somersetshire** (4 N.W. and N.E.), (9 S.W. and S.E.), 14 N.E., 16 N.E., 16 S.W., 18 S.W., 20 N.W., S.E., 25 S.W., S.E., 26 N.E., S.W., 27 S.E., 29 S.E., 30 S.W., 31 N.W., 34 N.E., 38 S.W., 41 N.W., 42 S.W., 42 S.E., 44 N.E. (44 S.E. and 56*a* N.E.), 52 S.E., 54 S.W., S.E., 64 N.W., 65 N.E., 73 N.E., 73 S.E., 75 N.E., S.W. **Staffordshire**, 71 S.E. **Suffolk**, 80 S.E., 81 S.W., 82 N.W., 83 S.E. **Warwickshire**, 6 S.W., 8 N.E. **Worcestershire**, 4 S.E., 19 N.W., N.E. **Yorkshire**, 284 N.E., 290 N.W., 301 N.W.

25-inch—County Maps (first revision):—

Brecknockshire, XXIX. 1, 5, 9, 13; XXX. 2; XXXIV. 2, 3, 4, 6, 7, 8, 10, 11, 12; XXXV. 1, 2, 3, 5, 6, 9, 10; XXXVI. 1, 9, 10; XXII. 14; XXIII. 14; XXIV. 5. **Devonshire**, VII. 3; IX. 1, 2, 3, 4, 5, 6, 7, 8; X. 3, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; XI. 5, 9, 10, 13, 14; XIV. 4, 8, 11; XV. 9, 10, 13; XXI. 3, 4, 7, 8; XXII. 1, 2, 4, 5, 6, 7, 8; III. 11, 15; VI. 11, 15, 16. **Herefordshire**, IX. 16; XIV. 2; XXXVII. 5; XLIII. 2; XLVII. 13, 15; LI. 9, 12, 16; LII. 2, 3, 6, 7, 8, 9, 10, 13, 14; LIII. 3; LIV. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11; LV. 1, 2. **Leicestershire**, X. 16; XI. 13, 14; XII. 13; XVII. 4; XVIII. 1. **Lincolnshire**, CXXX. 4; CXLVI. 3, 4, 13, 14; CXLVII. 1, 2, 3, 5, 8, 10, 11, 12, 16; CXLVIII. 1, 5, 9, 10; CLI. 3, 9. **Rutland**, VII. 13, 14; XIII. 15; XIV. 3, 6. **Somersetshire**, VI. 6; VII. 10; VIII. 6. **Suffolk**, XXXII. 5, 6, 7, 8, 11, 12, 15, 16; XXXIII. 5, 6; XLIII. 10, 14; XLIV. 2, 6, 9, 10, 11; XLV. 3, 5, 7, 10, 11, 12, 14, 15, 16; XLVI. 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; XLVII. 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; XLVIII. 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15; XLIX. 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16; L. 5, 6, 7, 8, 9, 11, 13 (16 and LI. 13); LI. 5, 9; LX. 1 (4 and LX*a*. 1); LXXVI. 2. **Warwickshire**, XIII. 10, 14, 15; XVI. 15, 16; XLII. 11. **Worcestershire**, III*a*. 16; V. 10, 13, 14, 15; VII. 11, 12, 14, 16; X. 1, 2, 3, 5, 6, 7, 9, 10, 11, 13, 14, 15; XII. 4; XVI. 1, 2, 3; XX. 13; XXX. 13, 14, 15; XXXIII. 2, 3, 4; XXXIV. 14, 15; XXXV. 1, 2, 3, 5, 6, 7, 9, 10, 11; XLI. 2, 3, 6, 7, 10, 11.

(*E. Stanford, London Agent.*)

Germany. **Königl. Preuss. Landes-Aufnahme.**

Karte des Deutschen Reiches. Scale 1:100,000 or 1·6 stat. mile to an inch. Sheets: 265, Gardelegen; 315, Luckenwalde. Herausgegeben von der Kartogr. Abtheilung der Kgl. Preuss. Landes-Aufnahme, [1904]. *Price* 1.50 *mark each sheet.*

Luxemburg. **Hansen.**

Carte topographique der Grand-Duché de Luxembourg par J. Hansen. Scale 1:50,000 or 1·3 inch to 1 stat. mile. Sheets: 1, Troisvierges; 2, Clervaux; 4, Wiltz; 5, Vianden; 7, Redange; 8, Diekirch-Mersch; 9, Echternach. Paris: Erhard Freres, [1904].

Since the year 1883 Mr. J. Hansen, of Paris, has been engaged upon a survey of the Grand Duchy of Luxembourg, on the scale of 1:20,000, the results of which are now being published on a reduced scale (1:50,000) in fifteen sheets, of which the above are the first five to be issued. The relief is shown by form lines in brown, resembling regular contours, while figures in the same colour express definite heights of points in metres. Roads, which are clearly distinguished according to their relative importance, are in red, and forests and wooded land in green. The map is clearly drawn, and generally well produced.

ASIA.

China. **Königl. Preuss. Landes-Aufnahme.**

Karte von Ost-China. Scale 1:1,000,000 or 15·8 stat. miles to an inch. Sheet: Tschang tu fu. Kartographische Abtheilung der Königl. Preuss. Landes-Aufnahme, 1904. *Price* 1.50*m.*

Chinese Turkestan. **Hedin.**

Map showing Dr. Sven Hedin's journey from Lajlik to Jangi-köl and to Jurttschapghan, 1899–1900. Scale 1:100,000 or 1·6 stat. mile to an inch. *Petermanns Geographische Mitteilungen*, Jahrgang 1904, Tafel 11. Gotha: Justus Perthes, 1904. *Presented by the Publisher.*

Eastern Asia. **The "Times."**

The *Times* Map of the Russo-Japanese War. Compiled from sources and telegrams practically exclusive to the *Times*. Scale 1:2,217,600 or 5 stat. miles to an inch. London: The *Times* Office, 1904. *Price* 5*s. net.*

Although many maps have been published of the seat of war in the Far East, as might be expected when it is remembered that, with the exception of the coast-line, nothing but rough route surveys have ever been attempted, these differ widely from

one another. Doubtless the best maps of Southern Manchuria and Korea are those which have been prepared from sketches of Japanese officers, but as these are in native character, they would be of little service to the ordinary individual in this country, even if they were readily accessible. The *Times* map certainly contains more names of places than most others, but it is in many respects very unreliable, and some serious errors occur, one being the course of the Lau ho, which is shown much too far to the west. The map is printed in colours, and is a decidedly rough production, but it will be found useful in following the operations of the Russo-Japanese war. In addition to the principal map, there are insets of the Siberian railway, Port Arthur, the port of Niu-chwang, and the approaches to Vladivostok.

Japan. **Japanese Imperial Geological Survey.**

Geological Survey of Japan Reconnaissance Map. Topography. Division 1. Scale 1 : 400,000 or 6·3 stat. miles to an inch. 4 sheets. Revised. Tokyo, 1900. *Presented by the Imperial Geological Survey of Japan.*

This is a revised edition of a general map of Japan which was first published in 1884.

Kwan-tung Peninsula. **Service Géographique de l'Armée, Paris.**

Environs de Port Arthur et de Dalny d'après le Carte Russe à 1 : 210,000, les croquis du Capitaine d'Amade et les cartes marines. Scale 1 : 100,000 or 1·6 stat. mile to an inch. Paris: Service Géographique de l'Armée, 1904. *Price* 1.25*fr.*

Philippine Islands. **Military Information Division, U.S.A.**

Map of the Philippine Islands. Scale 1 : 792,000 or 12·5 stat. miles to an inch. 4 sheets. Compiled from the latest official data in the Second (Military Information) Division, Office of the Chief of Staff, War Department, Washington, U.S.A., 1904. *Presented by the Chief of Staff, Second (Military Information) Division, U.S.A.*

AFRICA.

Africa. **Intelligence Division, War Office.**

Africa. Scale 1 : 250,000 or 3·9 stat. miles to an inch. Northern Nigeria (Provisional). Sheets: 62—A, B, E, F, I, J, M, N. London: Intelligence Division, War Office, 1904. *Price* 1*s.* 6*d. each sheet. Presented by the Director of Military Operations.*

Gold Coast. **Stanford.**

Sketch-map of the Gold Coast Government Railway, Sekondi to Kumasi, showing stations and positions of private sidings. Scale 1 : 253,440 or 4 stat. miles to an inch. Messrs. Shelford & Son, consulting engineers. *Price* 2*s.* 6*d.* London: Edward Stanford, 1904. *Presented by the Publisher.*

AMERICA.

Canada. **Surveyor-General's Office, Ottawa.**

Sectional Map of Canada. Scale 1 : 190,080 or 3 stat. miles to an inch. Carlton sheet (54), West of Third Meridian, revised to June 17, 1904; Vermilion sheet (71), West of Fourth Meridian, revised to June 17, 1904; Seymour sheet (92), West of Sixth Meridian, revised to July 5, 1904. Ottawa: Surveyor-General's Office, 1904. *Presented by the Surveyor-General of Canada.*

Nicaragua. **Bureau of the American Republics.**

Nicaragua. Scale 1 : 729,000 or 12·5 stat. miles to an inch. From official and other sources, prepared in the International Bureau of the American Republics, Washington, 1903. *Presented by the Director of the International Bureau of the American Republics.*

These two maps contain a considerable amount of information concerning the commercial and physical geography of Nicaragua. The first shows hills in brown shading, boundaries and rivers, in addition to which are indicated, by various symbols, telegraph lines, submarine cables, steamer lines, railways, the heads of navigation of rivers for steamships and canoes, gold and silver workings, altitudes in feet, and other interesting information. The second map shows the relief by tinted contours, and then by different symbols and colours, the districts of extensive cultivation of coffee, cacao, indigo, bananas, sweet potatoes, rice, sugar-cane, tobacco, and other agricultural products. As many parts of the country are but little known and only very roughly mapped, much of the information can only be considered approximate.

United States. **U.S. Geological Survey.**

Geologic Atlas of the United States. Scale 1 : 125,000 or 1·8 stat. mile to an inch.

Folios: 91, Hartville; 92, Gaines; 93, Elkland-Tioga; 94, Brownsville-Connellsville; 95, Columbia; 96, Olivet; 97, Parker; 98, Tishomingo; 99, Mitchell; 100, Alexandria; 101, San Luis; 102, Indiana; 103, Nampa; 104, Silver city; 105, Patoka; 106, Mount Stuart. Washington: Department of the Interior, U.S. Geological Survey, 1904. *Presented by the U.S. Geological Survey.*

AUSTRALASIA.

Australasia. **Stanford.**

Stanford's Library Map of Australasia. Scale 1:4,089,064 or 64·5 stat. miles to an inch. New edition. 4 sheets. London: Edward Stanford, 1904.

Important corrections have been made to this map since the last edition was published, but it still needs further revision, specially as regards German New Guinea, and the adjacent islands of New Pommern and Neu Mecklenburg, and the island of Celebes.

GENERAL.

World. **Hartleben.**

A. Hartleben's Volks-Atlas enthaltend 72 Karten in Einhundert Kartenseiten. Vierte-Auflage. Lieferungs 2–10. Vienna and Leipzig: A. Hartleben, [1904]. *Price 50pf. each part.*

The first issue of this atlas was noticed in the August number of the *Journal*. The present parts contain the following maps: Part 2, Physical map of the Alps; Norway and Sweden; Central America; Kaiser Wilhelm-Land and Bismarck Archipelago. Part 3, Colonial and Commercial map of the World; Upper and Lower Austria; Malay Archipelago; British South Africa. Part 4, Germany; Rumania; Caucasus. Part 5, Italy; South Brazil; Australia and Polynesia. Part 6, Polar Regions; Race distribution; European Russia; Egypt. Part 7, Switzerland; Bohemia, Moravia, and Silesia; America. Part 8, Special map of Germany; Balkan peninsula; Pacific islands. Part 9, Oceanic depths and currents; United Kingdom; Asia. Part 10, Austro-Hungary; South-west Russia; Asia Minor; Southern India.

World. **Petrie and Schokalsky.**

Marcks' Large General Table Atlas. Edited by Prof. E. J. Petrie and Colonel J. de Schokalsky. Part 7. St. Petersburg: A. F. Marcks, 1904. [In Russian.] *Presented by the Publisher.*

This part contains plates: 2–9, Climatological and ethnographical maps of the world; 13, Central Europe on the scale of 1:3,500,000; 27, European Russia (sheet 13) on the scale of 1:2,000,000.

CHARTS.

Admiralty Charts. **Hydrographic Department, Admiralty.**

Charts and Plans published by the Hydrographic Department, Admiralty, during May and June, 1904. *Presented by the Hydrographic Department, Admiralty.*

No.	Inches.	
3381 m =	6·9	Scotland, west coast. Hebrides, Lewis:—West Loch Roag. 3*s.* 6*d.*
3384 m =	14·0	Ireland, south coast:—Queenstown. 2*s.* 6*d.*
3415 m =	1·9	Baltic sea. Gulf of Bothnia:—Approaches to Räfsö and Biörneborg. 2*s.* 6*d.*
3416 m =	3·59	France, west coast:—Approach to Brest. 2*s.* 6*d.*
1233 m =	6·0 4·5	Black sea, plans:—Kustenjeh (Constanta) anchorage. Bender Erekli. 1*s.* 6*d.*
3405 m =	6·0	Newfoundland, east coast. Bay of Exploits:—Peter arm. 1*s.* 6*d.*
3390 m =	0·76 12·16	North American lakes. Lake Huron:—St. Clair river to Goderich (Plan:—Goderich harbour). 2*s.* 6*d.*
3424 m =	1·0	South America. Tierra del fuego. Beagle channel:—Cape San Pio to Gable island. 2*s.* 6*d.*
3425 m =	1·0	South America. Tierra del fuego. Beagle channel:—Gable island to Lapataia bay. 2*s.* 6*d.*
3426 m =	1·25 10·0	Philippine islands. Plans on the north coast of Mindanao:—Port Misamis. Port Langaran. 2*s.* 6*d.*
1016 m =	1·0	Cochin China:—Saigon or Don nai river. 2*s.* 6*d.*
2653 m =	2·4	China, north coast:—Peiho or Peking river, Sheet I., from the entrance to Ko-ku (*Reproduction*). 2*s.* 6*d.*
1663 m =	3·5 3·6	Japan. Plans on the south coast of Yezo:—Fukuyama byochi. Fukushima byochi. 1*s.* 6*d.*

No.
1772 Ireland, east coast. Approaches to Wexford harbour. Plan added:—Rosslare harbour.
2113 Sicily. Plans of anchorages on the west coast. Plan added:—Sciacca.
1149 Iceland. Plans on the west coast. Plans added:—Budir Krossvik.
801 West Indies. Haïtï or San Domingo. Approaches to Port au Prince. Plan added:—Jeremie bay.
3138 Alaska. Anchorages in south-east. Plan added:—Yes bay.
935 Eastern archipelago. Harbours and anchorages between Bali and Timor. Plan added:—Sermata, west point.
2468 Eastern archipelago. Selabu, west coast. Plan added:—Warain road.
2772 Sulu sea. Anchorages in Gillolo. Plans added:—Ekor and Galela roads. Bobani bay and Pasir Putih anchorage.
3392 Philippine islands. Plan added:—Port San Vicente.
1641 China, east coast. Harbours and anchorages on the coast of Formosa. Plan added:—Taihanroku anchorage.
1280 Korean archipelago. Port Hamilton. Plan added:—U-to anchorage.
1999 New Zealand. Ports Lyttelton and Levy. New Plan:—Lyttelton harbour.
2591 New Zealand. Sheet XIV. Plan added:—Greymouth harbour.
1490 South Pacific ocean. Harbours and anchorages in the Sandwich islands. Plan added:—Kaanapali anchorage.

(*J. D. Potter, Agent.*)

Charts Cancelled.

No.		Cancelled by	No.
1233	Kustenjeh anchorage.	New sheet.	
2387	Bendor Erekli.	Kustenjeh anchorage, Bender Erekli . .	1233
678	Goderich harbour. Plan on this chart.	New plan. Goderich harbour on chart	3390
803	Jeremie bay. Miragoane harbour.	Reduced plan of Jeremie bay on chart . .	801
599	Approaches to Ushuwaia Mission Station and Lapataia bay. Plans on this sheet.	New chart. Gable island to Lapataia bay	3425
581	Farewell harbour. Plan on this sheet.		
957	Port Misamis. Plan on this sheet.	New plan. Port Misamis	3426
2454	Port S. Vicente. Plan on this sheet.	New plan. Port San Vicente on sheet	3392
2653	Peiho or Peking river.	New plan of same	2653

(*J. D. Potter, Agent.*)

Charts that have received Important Corrections.

No. 1698, England, south coast:—Dover bay. 1185, England, river Thames:—Sea reach. 2030, Ireland, south-west coast:—Valentia harbour. 3158, Norway:—Newlunghavn to Torbiornskier. 3159, Norway:—Torbiornskier to Jœlöen. 3160, Norway:—Torbiornskier to Ranö. 1297, Norway:—Lepsö to Ona. 1298, Norway:—Approaches to Molde. 2307, Norway. Sheet V.: Smölen to Sves fiord. 2315, Norway. Sheet XIII.: Sörö to North cape. 2316, Norway. Sheet XIV.: North cape to Tana fiord. 2331, Baltic, Gulf of Finland:—Hangö head to Barö sound. 1458, Spain, east coast:—Ports and anchorages. 2740, Iceland and the Færoe islands. 565, Iceland, western portion. 566, Iceland, eastern portion. 3017, North American lakes:—Duluth and Superior harbours. 2538, Nova Scotia, Bay of Fundy:—Yarmouth to Petit passage. 2488, United States, east coast:—Portland harbour. 2580, West Indies:—Cuba, eastern portion. 2600, West Indies:—San Domingo to Dominica. 1501, Alaska, Aleutian islands:—Seguam island to Attu island. 1064, Madagascar:—Plans on the north-east coast. 40, India, west coast:—Karachi harbour. 859, Bay of Bengal:—Mutlah river to Elephant point. 934, Eastern archipelago:—Surabaya, etc. 3349, Cochin China:—Approach to Kwang chau wan. 3386, China, east coast:—Long harbour and approaches. 166, China, east coast:—Pagoda anchorage. 372, Japan, Kiusiu, west coast:—Gulf of Kagosima, upper part. 764, New Guinea, etc.:—New Hanover, New Ireland, and New Britain.

2527, New Zealand. Sheet III.: Mayor island to Poverty bay. 2411, New Zealand:—Otago harbour. 1913, New Hebrides:—Malekula, Northern part. 1579, New Hebrides:—Malekula, southern part.
(*J. D. Potter, Agent.*)

North Atlantic and Mediterranean. **Meteorological Office.**

Pilot Chart of the North Atlantic and Mediterranean for August, 1904. London: Meteorological Office. *Price 6d. Presented by the Meteorological Office, London.*

United States Charts. **United States Hydrographic Office.**

Pilot Chart of the North Atlantic Ocean for July, and of the North Pacific Ocean for August, 1904. U.S. Hydrographic Office, Washington, D.C., 1904. *Presented by the U.S. Hydrographic Office.*

PHOTOGRAPHS.

California.

An album of twenty-two views of the Spanish Mission Stations in California. *Presented by C. H. Wallroth, Esq.*

Mr. Wallroth is a most generous contributor to the Society's collection of photographs, and many excellent albums have been presented by him. To these he now adds this interesting set of large photographic reproductions, which appeared in the supplement to the San Francisco *Sunday Chronicle* for September 13, 1903:—

(1) Ruins of Mission San Diego de Alcala; (2) Mission San Luis Rey de Francia; (3) Mission San Antonio de Palo; (4) Ruins of the old Mission San Juan Capistrano; (5) Mission San Gabriel Arcangel; (6) Mission San Fernando Rey de Espana; (7) Mission San Buena Ventura; (8) Mission Santa Inez; (9) Mission La Purisima Concepcion; (10) Mission Santa Barbara; (11) Mission San Luis Obispo de Tolosa; (12) Mission San Miguel; (13) Mission San Antonio de Padua; (14) Mission San Juan Bautista; (15) Mission Nuestra Senora de la Soledad; (16) Mission San Carlos Borromeo; (17) Mission Santa Cruz; (18) Mission San Jose; (19) Mission Santa Clara; (20) Mission San Francisco de Asis; (21) Mission San Rafael Arcangel; (22) Mission San Francisco de Solano.

China. **Hicks-Beach.**

Thirty photographs of North China and Mongolia, taken by M. H. Hicks-Beach, Esq. *Presented by M. H. Hicks-Beach, Esq.*

These photographs were taken during the journey of Messrs. Russell and Hicks Beach described in the *Geographical Journal* for May last. They are of special interest from the fact that our knowledge of a greater part of the region traversed is very slight. The titles are as follows:—

(1) The Prince of Chastuchi; (2) The Prince of Chastuchi and suite; (3) Prince's enclosure, Chastuchi; (4) Guest huts, Chastuchi; (5) Fording a stream in Mongolia; (6 and 7) Mongol men and boys; (8) Mongol men and women; (9) Mongol men; (10) Mongol huts; (11) Mongols with salt-carts; (12) Mr. Russell's servants, transport mules and ponies; (13 and 14) Mongolian ponies; (15) A valley in Mongolia; (18 and 19) Lamassery, Ying Cheka Miao; (20) Parta; (21) Plaster relief on wall of Parta; (22) Hot springs, Lung Shan; (23) Farm house group in Wei Cheng; (24) Fording the I-sun Ho; (25) Lama temple, Jehol; (26 and 27) Lamassery, Jehol; (28) Carts in courtyard of inn at Jehol; (29) Execution procession, Jehol; (30) The Great Wall at Kupikiu.

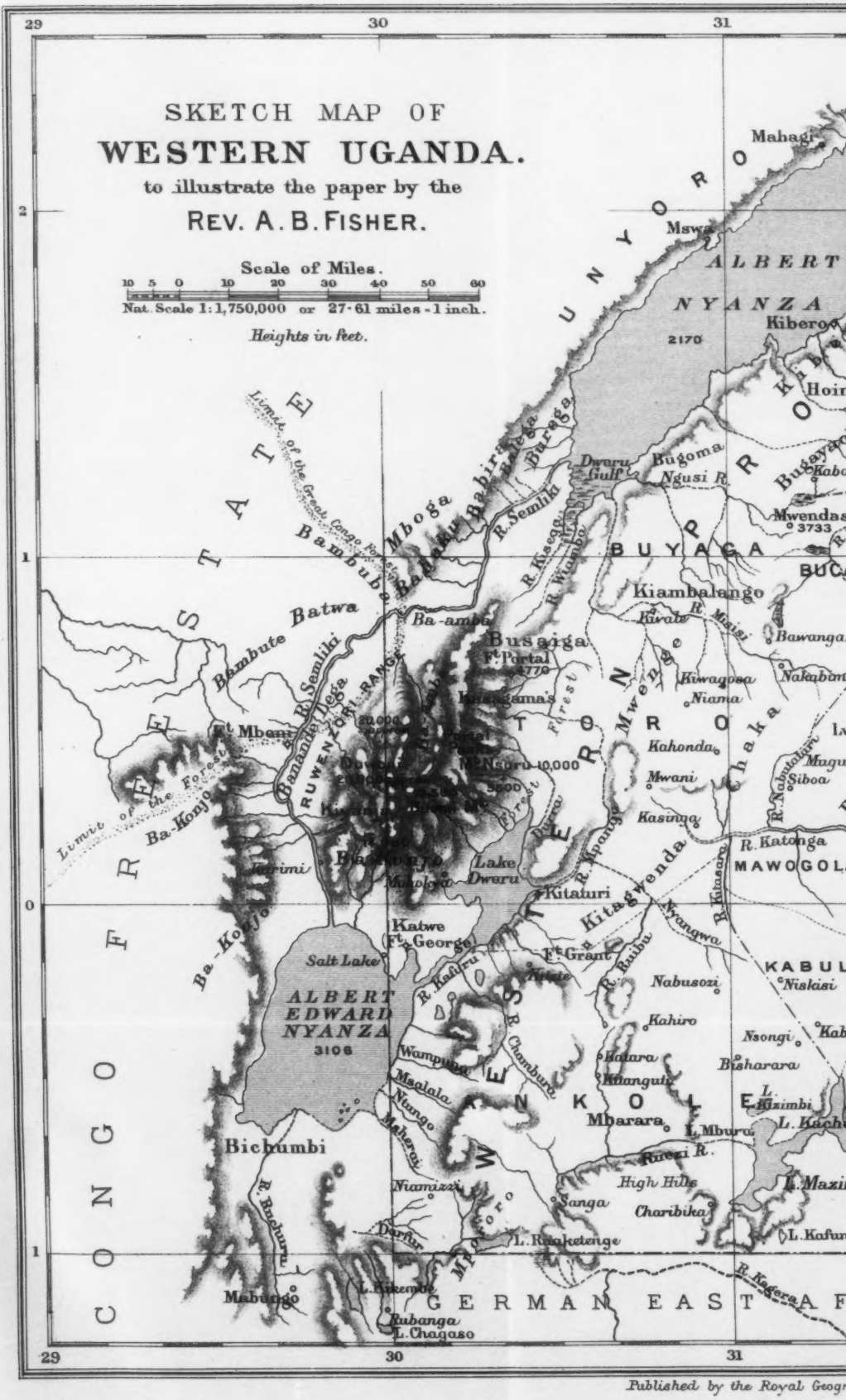
Nyasaland.

Six photographs illustrating the tobacco cultivation in Nyasaland.

All who are specially concerned in the development of British Central Africa will be interested in these photographs. They are half-plates, and are very good specimens.

(1) Preparation of soil; (2) Curing-barn in course of erection; (3) Seed beds under gauze; (4) Tobacco leaf specimens; (5) Curing-shed; (6) Plantation, Havana plants.

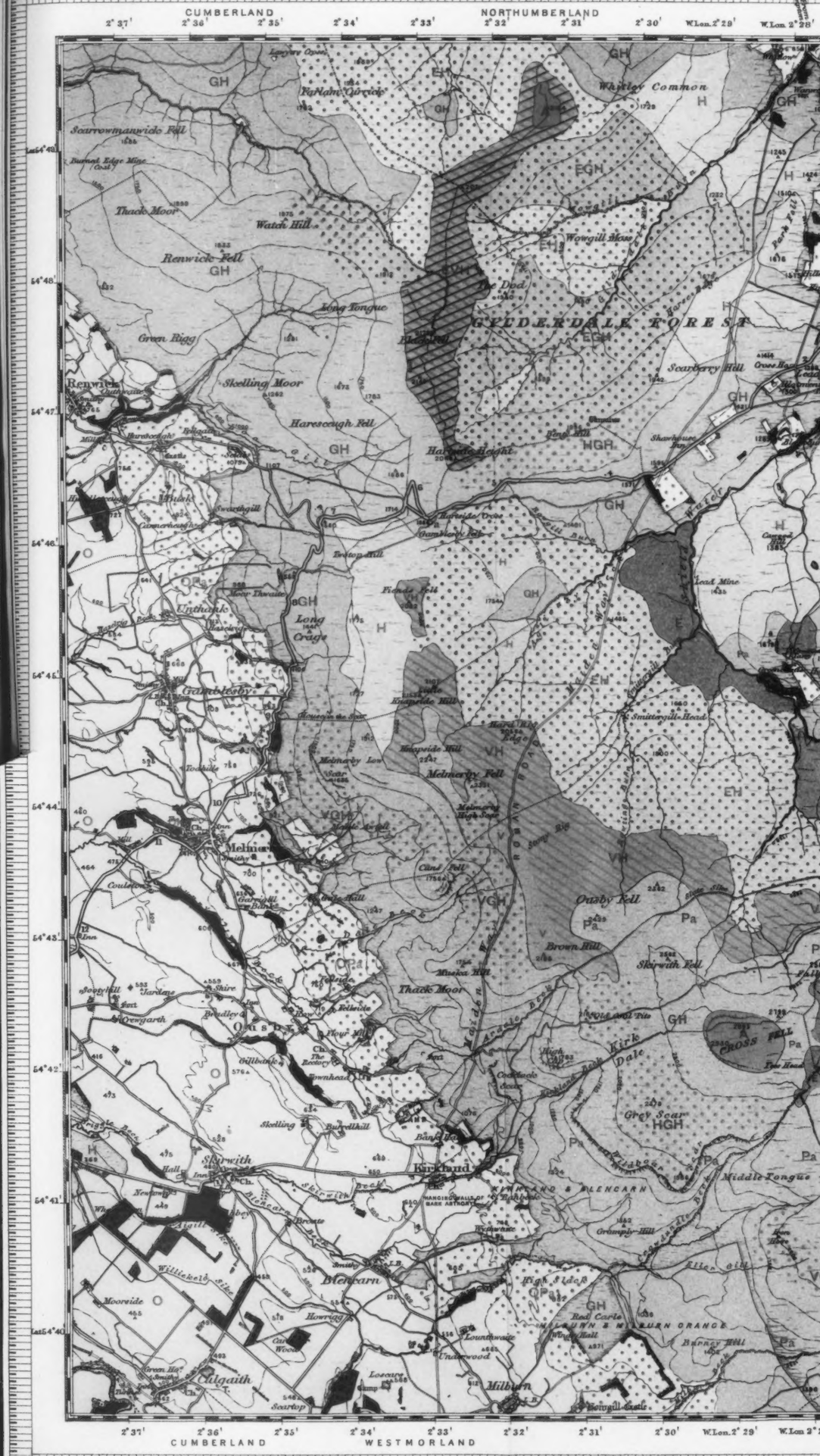
N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.


SKETCH MAP OF
WESTERN UGANDA.
to illustrate the paper by the
REV. A. B. FISHER.
Scale of Miles.
10 5 0 10 20 30 40 50 60
Nat. Scale 1:1,750,000 or 27·61 miles = 1 inch.
Heights in feet.
29
30
31
2
1
0
1
CONGO FREE STATE
GERMAN EAST AFRICA
UNYORO
TORO
BUYAGA
BUGANDA
KABULEGA
MAWOGOLA
ALBERT NYANZA
2170
Mahagi
Mswa
Kibero
Hoima
Dweru Gulf
Ngusi R.
Mwendas
3733
Kiambalango
Kivale
Bawanga
Busaiga
Ft. Portal
4770
Kiwagosa
Niama
Nakabam
Kahonda
Mwani
Siboa
Kasinga
R. Katonga
Mbeni
Mt. Nsuru 10,000
Kitaturi
Lake Dweru
Katwe
Ft. George
Salt Lake
ALBERT EDWARD NYANZA
3108
Ft. Grant
Nabusozi
Kahiro
Nsongi
Busharara
Wampuna
Msalala
Ntungo
Mahera
Mbarara
L. Mburo
Bichumbi
Niamizzi
High Hills
Sanga
Charibika
Darfur
L. Rikaketenge
L. Kafur
Mabungo
L. Rikemba
Rubanga
L. Chagaso
Limit of the Great Congo Forest
Ba-Konjo
Bambute
Batwa
Mboga
Badaka
Babirisa
Baraga
R. Semliki
R. Kisegga
R. Muombo
Ba-amba
Bamanda
Lega
RUWENZORI RANGE
R. Mpanga
R. Kitagwenda
R. Kasaro
R. Nabutakiri
Chaka
Forest
Limit of the Forest
Ba-Konjo
R. Kafuru
R. Chambura
R. Ruizi
R. Kagera
Published by the Royal Geogr

WESTERN UGANDA.

FISHER.

Geographical Society.


CUMBERLAND
NORTHUMBERLAND
2° 37'
2° 36'
2° 35'
2° 34'
2° 33'
2° 32'
2° 31'
2° 30'
W.Lon. 2° 29'
W.Lon. 2° 28'
54° 49'
54° 48'
54° 47'
54° 46'
54° 45'
54° 44'
54° 43'
54° 42'
54° 41'
54° 40'
Scarrowmanwicke Fell
Thacke Moor
Watch Hill
Renwick Fell
Green Rigg
Long Tongue
Skelling Moor
Haresceugh Fell
Renwick
Unthank
Gamblesby
Long Crag
Melmerby
Melmerby Fell
Cloud Fell
Ousby
Ousby Fell
Brown Hill
Skirwith Fell
Thacke Moor
Kirkland
Skirwith
Blencarn
Culgaith
Mooreside
Lowaire Camp
Scartop
Milburn
Whitley Common
Wowgill Moss
The Dod
GRUDERDALE FOREST
Scarberry Hill
Harescough Height
Smittergill Head
Middle Tongue
Grey Scar
Cross Fell
Crumply Hill
Red Carle
Burney Hill
Penrith
Appleby
Alston
Brampton
Carlisle
Hexham
Haltwhistle
Brough
Kirkby Stephen
Penrith
Keswick
Cockermouth
Workington
Whitehaven
Maryport
Wigton
Aspatria
Silloth
Longtown
Brampton
Carlisle
Hexham
Haltwhistle
Alston
Brough
Kirkby Stephen
Appleby
Penrith
Keswick
Cockermouth
Workington
Whitehaven
Maryport
Wigton
Aspatria
Silloth
Longtown
Roman Road
Roman Road
Roman Road

HICAL DISTRIBUTION OF VEGETATION IN THE BASINS OF THE RIVE

BY FRANCIS J. LEWIS, F.L.S., UNIVERSITY OF LIVE

Scale of One Inch to One Statute Mile

The Altitudes are given in Feet above the assumed Mean Level of the Sea at Liverpool, which is 0·650 of a Foot below the general Mean Level of the Sea.

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Published by the Royal Geographical Society.

E RIVERS EDEN, TEES, TYNE & WEAR - PART II.

OF LIVERPOOL.

Railways, Single Line ..... Level Crossing ..... Bound

Two or more Lines ..... Cutting Embankment ..... At Villa

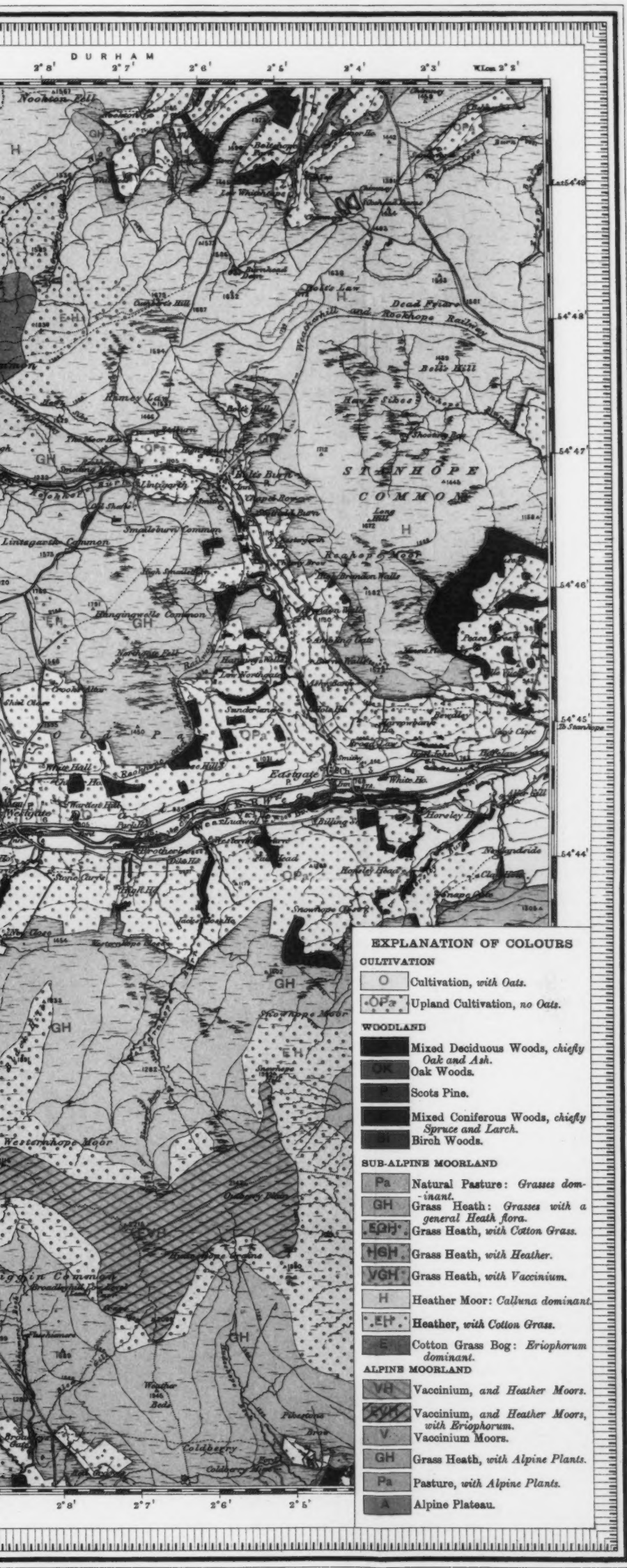
Bridge Over Bridge Under

Mineral Lines and Tramways .....

Rivers and Streams when exceeding 15 feet in width are shown

Miles

Mean Level of the Sea, and are indicated thus (326)



Boundaries. County.....
" Parish.....
Villages { Post Office ..... P.
Post & Telegraph Office ..... T.

shown with two lines.

Printed by John Bartholomew & Co.
The Edinburgh Geographical Institute